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SP88-047

THE DEGRADATION STUDY OF A METALS-TOLERANT FLUID CATALYTIC CRACKING CATALYST BY MOLECULAR PROBES

D. P. Surette

April, 1988

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Final Report

by

D. P. Surette

April, 1988

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TABLE OF CONTENTS

Page No.

SUMMARY i

1. INTRODUCTION 1

- 1.1 Objective 1
- 1.2 Preliminary 2

2. EXPERIMENTAL 5

- 2.1 Fixed Bed Cracking 5
  - 2.1.1 Microactivity Test (MAT) 5
    - 2.1.1.1 Apparatus 5
    - 2.1.1.2 Reactor Loading 6
    - 2.1.1.3 Operation 6
  - 2.1.2 GC-MS Analysis 8
  - 2.1.3 Gas Analysis by Mass Spectrometry 8
  - 2.1.4 Coke Analysis 9
- 2.2 Feedstocks 9
- 2.3 Catalyst 9
  - 2.3.1 Decoking 10
  - 2.3.2 Preparation of Coked Catalyst 10
  - 2.3.3 Hydrothermal Deactivation 10
  - 2.3.4 Thermal Deactivation 12
  - 2.3.5 Metals Impregnation 12

3. RESULTS AND DISCUSSION 13

- 3.1 Experimental and Analytical Data 13
  - 3.1.1 Reactor Effluent Composition 13
  - 3.1.2 Detailed Analytical Results 13

TABLE OF CONTENTS Continued

Page No.

3.2 Task 1 Cracking Yields for Normal Paraffins 14
  3.2.1 Experimental Design 14
  3.2.2 Microactivity Test Results 14
    3.2.2.1 n-Octadecane 15
    3.2.2.2 n-Hexacosane 17
    3.2.2.3 n-Dotriacontane 18
  3.2.3 Standard Cracking Parameters 19
  3.2.4 Molecular Yields 20
    3.2.4.1 Product Cut Points and Hydrocarbon Distribution 20
    3.2.4.2 Reactor Effluent Composition 21
    3.2.4.3 Carbon Number Distributions 21
    3.2.4.4 Hydrocarbon Type Distribution 23
    3.2.4.5 Cracking Severity and Product Quality 25
  3.2.5 Effects of Molecular Weight 27

3.3 Task 2 Cracking Yields for Other Hydrocarbons 28
  3.3.1 Experimental Design 28
  3.3.2 Experimental Results 28
    3.3.2.1 2,6,10,14-Tetramethylpentadecane 29
    3.3.2.2 1-Octadecene 30
    3.3.2.3 1,3,5-Triisopropylcyclohexane 31
    3.3.2.4 1,3,5-Tri-t-Butylbenzene 33
    3.3.2.5 1-Phenyldodecane 34
    3.3.2.6 Fluorene 36
    3.3.2.7 9-Phenylfluorene 36
  3.3.3 Feedstock Considerations 37

TABLE OF CONTENTS Continued

Page No.

3.4 Task 3 Cracking Yields for Major Sulfur and Nitrogen Species 38
  3.4.1 Experimental Design 38
  3.4.2 Experimental Results 38
    3.4.2.1 1-Octadecanethiol 38
    3.4.2.2 Undecylsulfide 40
    3.4.2.3 Octylsulfide 41
    3.4.2.4 Dibenzothiophene 43
    3.4.2.5 2,6-Di-t-Butyl-4-Methylpyridine 43
    3.4.2.6 9-Phenylcarbazole 43
  3.4.3 Considerations for Major Sulfur and Nitrogen Feedstocks 44

3.5 Task 3A Effects of Nitrogen Poisoning on Cracking Yields 45
  3.5.1 Experimental Design 45
  3.5.2 Microactivity Test Data 45
  3.5.3 On the Effects of Basic Nitrogen in FCC Feedstocks 46
  3.5.4 On the Atypical Behaviour of "Blend A" 47

3.6 Task 4 Key Component Blends and Synergistic Cracking Effects 49
  3.6.1 Key Component Blends 49
  3.6.2 Microactivity Test Results 49
  3.6.3 Theoretical Product Yield Structures 49
  3.6.4 Synergistic Effects 50

TABLE OF CONTENTS Continued

Page No.

3.7 Task 5 The Effects of Residual Catalyst Coke on Cracking Yields 52
3.7.1 Deactivation by Coke 52
3.7.2 Microactivity Test Run Results 52
3.7.3 The Effects of Residual Coke 52

3.8 Task 6 Hydrothermal Deactivation of Cracking Catalyst 55
3.8.1 Hydrothermal Stability 55
3.8.2 Microactivity Test Results 56
3.8.3 Extreme Thermal deactivation 56

3.9 Task 7 The Effects of Metals Impregnation on Catalyst Cracking 58
3.9.1 Metals Deactivation 58
3.9.2 Cracking Yields for Metals Impregnated Catalysts 58
3.9.3 The Effects of Nickel Poisoning 58
3.9.4 The Effects of Vanadium Poisoning 59
3.9.5 The Effects of Nickel and Vanadium 60
3.9.6 On the Cracking of Gas Oils 60

3.10 Task 8 Determination of Catalyst Properties 62
3.10.1 Physical and Chemical Properties 62
3.10.2 Analytical Results 62

4. CONCLUSIONS 64

TABLE OF CONTENTS Continued

Page No.

5. RECOMMENDATIONS 66

6. REFERENCES 67

7. ACKNOWLEDGEMENT 70

TABLES

FIGURES

APPENDICES

SOMMAIRE

Le but de ce projet était de trouver un moyen d'évaluer des catalyseurs de craquage catalytique stables et résistant aux métaux en utilisant des composés unimoléculaires (c.-à-d. purs) comme charges d'alimentation. Il s'agissait de trouver un moyen d'évaluer des catalyseurs de craquage utilisés pour le traitement de résidus de façon à mieux comprendre les réactions qui surviennent au cours du craquage catalytique de charges d'alimentation composées de brut lourd ou de brut synthétique et d'optimiser les rendements et la qualité des carburants de transport produits.

Le projet portait sur sept études distinctes dans deux secteurs clés, soit (1) le craquage de charges d'alimentation modèles telles que des paraffines, d'autres d'hydrocarbures, les principales espèces de composés à base de soufre et d'azote et des mélanges de composés clés et (2) les effets des principaux mécanismes de désactivation des catalyseurs tels que la formation de coke sur le catalyseur régénéré, la désactivation hydrothermique et la contamination par les métaux. On a également étudié des procédés spéciaux pour le traitement préalable des catalyseurs tels que l'imprégnation à l'aide de métaux et la désactivation hydrothermique. On a également déterminé les propriétés physiques et chimiques des catalyseurs étudiés.

Les travaux ont démontré que certaines caractéristiques du mélange final de catalyseur (zéolite, matrice et liant), telles que la stabilité hydrothermique ou la tolérance aux métaux, sont déjà présentes jusqu'à un certain point dans les catalyseurs de craquage catalytique fluide offerts sur le marché. On a constaté une déficience sur le plan de la résistance à l'azote, qui fera l'objet d'études supplémentaires. L'utilisation de composés unimoléculaires et les renseignements détaillés sur les rendements moléculaires se sont révélés d'une très grande utilité pour l'étude des réactions fondamentales de craquage, d'autant plus qu'ils ont permis d'évaluer la qualité des produits.

La composition des charges d'alimentation a été définie comme un paramètre important pour l'étude des effets de la désactivation du catalyseur par différents processus tels que la contamination par les métaux ou l'azote.

De même, il est difficile de prévoir le rendement de craquage à l'aide des données sur la composition des charges d'alimentation en raison des effets synergiques des mélanges sur le craquage.

Cette étude de fond a permis de définir des sujets spécifiques nécessitant des études plus poussées ayant pour but d'optimiser la production de carburants de transport grâce au craquage catalytique fluide de bruts lourds ou synthétiques. Deux de ces sujets, en ce qui a trait aux catalyseurs, sont la résistance à l'azote et la sélectivité envers le coke. Une meilleure connaissance des composés spécifiques des bruts lourds et synthétiques de l'Ouest canadien qui sont responsables de la désactivation des catalyseurs permettrait d'améliorer les catalyseurs ou les méthodes de traitement préalable des charges d'alimentation à des fins de passivation.

SUMMARY

This project was proposed in order to develop a means of evaluating stable, metals-tolerant catalytic cracking catalysts using unimolecular (i.e. pure) compounds as feeds - molecular probes. This would provide a means for assessing residua processing cracking catalysts so that the reactions which occur during the catalytic cracking of heavy and synthetic crude feedstocks can be better understood and the yields and quality of liquid transportation fuels optimized.

The work covered seven special topics in two key areas namely 1) the cracking of model feedstocks such as paraffins, other hydrocarbons, major sulfur and nitrogen species and key component blends, and 2) the effects of major catalyst deactivation mechanisms such as coke on regenerated catalyst, hydrothermal deactivation and metals poisoning. Also included were special catalyst pretreatment procedures such as metals impregnation and hydrothermal deactivation as well as the determination of physical and chemical properties of catalyst samples.

This work has shown that certain traits in the final catalyst mix of zeolite, matrix and binder, such as hydrothermal stability or metals-tolerance, are already available in commercial fluid catalytic cracking catalyst to some degree. Nitrogen resistance was identified as a weak point which requires further investigation and refinement. The use of molecular probes together with detailed molecular yields were found invaluable in studying the fundamental cracking behaviours with the added feature of product quality assessment.

Feedstock composition was identified as an important parameter in assessing the effects of catalyst deactivation by various mechanisms such as metals or nitrogen poisoning. Similarly, the prediction of cracking yields based solely on feedstock composition data is complex due to the synergistic cracking effects of blending.

Specific areas have been identified as a result of this fundamental work as requiring further comprehensive investigation and study in order to optimize transportation fuel production from heavy oil and synthetic crudes by means of fluid catalytic cracking. Two such areas from a catalyst vantage are nitrogen resistance and coke selectivity while a better appreciation of the specific compounds responsible for catalyst deactivation found in Western Canadian heavy oils and synthetic crudes would allow for superior catalyst design and/or feedstock pretreatment aimed at passivation.

1. INTRODUCTION

1.1 Objective

The overall objective of this project is to evaluate the viability of producing transportation fuels from Western Canadian heavy oil or synthetic crudes by helping to develop an appreciation and understanding of the catalytic processes which occur during cracking with hydrothermally stable, metals-tolerant catalysts. Both product and molecular yield data obtained from microactivity testing (MAT) of pure components and blends of pure compounds, similar to those found in heavy oils and synthetic crudes, would allow an assessment of the desirable fluid catalytic cracking catalyst properties used to upgrade these materials. This would provide a tool and background data necessary for evaluating future candidate catalysts developed for the purpose of upgrading these types of feedstocks.

The specific and immediate objectives of this work are:

- to study the cracking behaviour for pure hydrocarbon species and typical nitrogen and sulfur impurities found in heavy oil and synthetic crude feedstocks by evaluating experimental MAT product and molecular yields such that these yields can be used to estimate Fluid Catalytic Cracking Unit (FCCU) yields from feed compositional analyses alone.
- develop a blend or blends of pure components to be used to study the sensitivity of catalyst degradation and thus compile data necessary to correlate the catalyst cracking behaviour with its physical and compositional properties.

1.2 Preliminary

At over 2.4 billion barrels, the heavy oil and tar sand reserves of the Western Provinces represent a strategic source of future Canadian hydrocarbons (1,2,3). These materials are geologically immature hydrocarbons rich in aromatic and cycloparaffin species and particularly deficient in paraffins which are found in large concentrations in conventional, mature crude oils (4). Previous work supported by CANMET Energy Laboratories has dealt with the upgrading by fluid catalytic cracking of heavy oil residua and coker gas oils from Western Canadian heavy oil and synthetic crudes (5,6). These residua can be catalytically cracked provided the additional coke formed during processing and the high levels of metals contamination can be tolerated.

Heavy oils and synthetic crudes have traditionally been considered poor fluid catalytic cracking unit feedstocks because of their high levels of deleterious impurities (7). Moreover the chemical composition of these streams is so distinct and unique that the processing and product quality implications must be addressed.

Sulfur affects product quality and impacts directly in the environment as it leads to high sulfur levels in liquid products and large sulfur oxide emissions from the regenerator. The latter can be overcome by blending special metal oxide catalyst additives in with the circulating catalyst inventory which absorb SO_3 in the regenerator to form sulfates and which, in turn, are reduced to hydrogen sulfide in the riser preventing the escape of SO_x to the atmosphere (8,9,10). Hydrogen sulfide and high sulfur liquids can be treated by conventional processing to produce quality fuels. Basic nitrogen compounds are known to reduce catalyst activity by blocking the active acid sites on the catalyst thus preventing the catalytic cracking reactions from occurring (11,12, 13). Better or novel catalyst design at the zeolite or matrix level may very well reduce or minimize these effects since it has been shown that high zeolite content and matrix type play a role in enhancing the nitrogen resistance of fluid catalytic cracking catalysts (14). Metal, and especially nickel and vanadium, present at increasing levels within heavier feedstocks have different but equally deleterious effects on catalyst performance. Fresh nickel deposited on cracking catalyst leads to dehydrogenation reactions and the formation of excessive amounts of coke without affecting the stability or structure of the zeolite (15).

Vanadium, however, permeates the zeolite crystal and, in the form of vanadium pentoxide, will form a eutectic compound with a fairly low melting point which ultimately results in the destruction of the zeolite crystal structure (16). The coking propensity of a given feedstock is related to the measured Conradson carbon residue (CCR) which for Athabasca bitumens has been shown to be very high (17). Coke precursors also affect catalyst performance in that they form coke deposits which blind the more active sites unless the coke is completely removed by oxidative regeneration. Coke on regenerated catalyst, therefore, adversely affects activity and the selectivity of the catalyst for products. In addition, high coke lay down on the catalyst leads to high catalyst particle temperatures on regeneration. Ultimately this will result in greater stress on the catalyst in terms of both thermal and hydrothermal degradation and poorer unit retention due to binder or matrix failure. Clearly, the mechanisms by which heavy oil and synthetic crude feedstocks can deactivate zeolitic cracking catalysts are many.

The experimental work presented herein deals with the cracking of individual hydrocarbon species representative of the types found in heavy oils. This work provides for a better understanding of the cracking yields of these compounds and thus will facilitate correlations between heavy oil composition and cracking yields for particular catalysts. Based on the results obtained for pure compounds and blends, these and other key formulations can be developed to be used to monitor catalysts for a variety of induced catalyst deactivations. This would allow catalysts to be evaluated and perhaps provide some insight into the preparation of a superior residuum cracking catalyst.

Zeolitic cracking of pure hydrocarbons has been extensively studied and covers a wide variety of compounds. Normal alkanes have been used to define catalytic cracking activity (18,19,20) and to study the kinetics of catalytic cracking (21,22) for a number of different synthetic zeolites. Cracking studies with other synthetic zeolites have included branched chained paraffins, alkenes, and aromatic compounds (23,24).

The present program is a logical extension of this work to commercial fluid catalytic cracking catalyst and to the mechanisms which deactivate them. Developing a better understanding and appreciation for the deactivation processes in the inorganic catalyst and the feedstock impurities which give rise to them advance the cause of synthesizing superior catalysts so that the maximum liquid yield of transportation fuels can be obtained from heavy oil and synthetic crudes by fluid catalytic cracking. Metals tolerance, hydrothermal stability, nitrogen resistance and coke selectivity are the four principal characteristics sought which will improve the economics of such upgrading making it commercially viable sooner.

2. EXPERIMENTAL

2.1 Fixed Bed Cracking

2.1.1 Microactivity Test (MAT)

The microactivity test (MAT) was the primary experimental method used in this work. The procedure employed is a modification of ASTM D3907-80, which is a standard method evaluating FCCU catalyst activity (25) . In the ASTM method, the gasoline yield (IBP-216°C) of a standard feed is determined at standard conditions of temperature (482°C), cat/oil ratio (3 m/m), and contact time (75 s). The procedure was modified so that reactor temperature, hydrocarbon feedstock, catalyst and contact time could be varied. The total MAT product range - gases, liquids and coke on spent catalyst - was determined such that a complete product yield structure for the MAT experiment could be calculated. These products included hydrogen, dry gas, C_3C_4, C_5S, gasolines (C_5-221°C, C_6-221°C), light cycle oil (221-344°C), decant oil (344+°C) and coke.

The MAT is a fixed bed downflow reactor constantly swept by an inert gas (nitrogen) during the course of the experiment. While it is operationally quite different than a commercial riser unit, experience and the literature (26) have shown that the directional changes in operating conditions in both units are reflected in similar changes in product yields.

2.1.1.1 Apparatus

A schematic diagram of the experimental apparatus is shown in Figure 2.1.1 and the description of the apparatus and its operation follow. The MAT reactor was a 400 mm x 14 mm O.D. pyrex tube fitted with a male 14/23 ground glass joint on the bottom and a 6 mm septum port on top. The reactor was equipped with a 20 mm x 8 mm side arm 10 mm from the top and terminated with a 12/5 ball joint. A pyrex disk was attached to the reactor 200 ± 10 mm from the top and served to support the catalyst bed. The disk was fitted with a 3 mm O.D. drip tube in the center to allow product flow. The receiver was a 120 mm x 14 mm O.D. tube with a round bottom and a 45 mm O.D. bulb blown on the top terminated by a female 14/23 ground glass joint. A 20 mm x 8 mm side arm with a 12/5 ball joint was attached to the upper part of the bulb. The downcomer, a 330 ± 20 mm x 6 mm O.D. pyrex tube opening to a 9 mm wide flute on top and reduced to a 1 mm I.D. tip at the bottom, was sealed to the top of the bulb, such that the tip came to within 1 mm of the receiver bottom and the flute reached a minimum of 3 mm beyond the bottom of the drip tube when the receiver and reactor were assembled. The gas collection system was assembled from a 2-L aspirator bottle to which a weir and graduate cylinder receiver were attached to the bottom tubulation by means of soft silicon tubing. The bottle was stoppered and fitted with the necessary glass tubing and valving system which would allow a) bypassing and purging, b) the collection and subsequent sampling of the reactor effluent gas, and c) the refilling of the collection bottle with brine.

2.1.1.2 Reactor Loading

A 2 to 4 mm thick pyrex or quartz wool plug was placed over the support disk in a clean, dry reactor. The desired amount of catalyst to be studied was weighed by difference into the reactor and the weight recorded to within 1 mg. A second glass fiber plug was placed above the lightly compacted catalyst bed and the remaining upper reactor dead volume was filled with clean, dry 3 mm pyrex beads to within 5 mm of the bottom of the side arm. The top was then sealed with a septum cap and two J type subminiature thermocouples (Omega SICSS-032V-12 or similar) were attached to the outer skin of the reactor in such a way as to measure the temperature at the top and middle of the catalyst bed.

2.1.1.3 Operation

The fully charged and prepared reactor was placed in a vertical tube furnace (Hoskins Type FD303A or similar) and a nitrogen line attached to the upper side arm ball joint. Nitrogen flow through the reactor was adjusted to 20 ± 1 mL/min once the reactor had reached the desired temperature. The reactor was allowed to purge at temperature for at least 20 minutes before a preweighed receiver was attached to the bottom of the reactor. The receiver was kept at wet ice temperature by immersing in a bath of crushed ice and water up to the bottom of the bulb. The gas collection system, once refilled and ready for use, was connected to the receiver outlet and the valves set for pre-run purge. Once the reactor had reached thermal equilibrium at the desired temperature, the nitrogen flow rate was adjusted to 20 ± 1 mL/min and the differential pressure across the bed was measured using a manometer or calibrated differential pressure transducer connected to the inlet nitrogen line. The temperature at the top and middle of the bed were recorded as were the ambient room temperature and barometric pressure.

The hydrocarbon feedstock to be tested was charged to a 5 mL glass syringe fitted with a Hamilton H86725 minivalve. After filling the syringe with feed and excluding all air, excess feed was forced out leaving approximately 2 mL at which time the valve was closed and the syringe assembly weighed.

A clean preweighed 180 mm, 20 ga. needle was attached to the syringe assembly and inserted through the septum at the top of the reactor such that the tip of the needle projected a minimum of 30 mm below the reactor side arm. The syringe was clamped into position on the feed pump (Sage Model 355 or similar, Orion Research Inc.) and the pump piston was seated firmly against the top of the syringe piston to insure feed injection began as soon as the pump was switched on.

Time zero was marked by the start of feed injection which was initiated by turning on the feed valve and syringe pump simultaneously. The gas flow from the receiver was immediately diverted to the gas collection bottle and the displaced brine collected in a 1000 mL graduated cylinder. At the end of feed injection, the pump was turned off as was the feed valve. Nitrogen was allowed to continue purging the reactor-receiver, stripping both the reactor of liquids and the receiver of light petroleum gases. During the initial stages of the run, the maximum differential bed pressure as well as the minimum nitrogen flow rate and skin temperatures of the top and middle of the reactor bed were recorded.

At the end of 900 seconds total elapsed time, the MAT run is complete. The gas collection system was isolated, the furnace was turned off and the liquid receiver was removed from the apparatus, dried and weighed when cool. The liquid in the receiver was then made as homogeneous as possible and an aliquot transferred to a small 1.5 mL serum capsule, sealed and refrigerated for later analysis. The total volume of brine displaced was recorded and an aliquot of the collected gas was taken in an evacuated 250 mL pyrex gas sampling tube for analysis. Once the reactor had cooled to room temperature under nitrogen flow, it was removed from the apparatus and the catalyst recovered as completely as possible. The catalyst was homogenized by shaking before being analyzed for total carbon.

The liquid sample was first analyzed by GC-MS to obtain the hydrocarbon type composition and then by gas chromatographic simulated distillation (GCD) using an HP 5880A system. The gas sample composition was determined by low resolution mass spectrometry within 24 hours of collection. Total carbon on catalyst was determined using a LECO instrument. This completes the microactivity test.

2.1.2 GC-MS Analysis

A gas chromatography-mass spectrometry (GC-MS) method was used to analyze the MAT reactor effluent liquid into its hydrocarbon group types. A Carlo-Erba gas chromatograph model 4160 with a split/splitless column injector and heated capillary flow restrictor coupled to a KRATOS MS-25 low resolution mass spectrometer were used. Instrument supervisory and control functions as well as data acquisition were provided by a KRATOS DS-55 hardware/software package running on a Data General Eclipse S-120 system.

Approximately 0.5 μL of sample were injected onto a 30 m x 0.32 mm I.D. methyl-silicon capillary column (0.25 μm wallcoating) at a 50:1 split ratio. Injector temperature was held at 350°C with an oven temperature programmed at 4°C/min starting at 5°C. At 275°C the temperature ramp was stoped and held for a 15 minute isothermal period. Simultaneously to the start of the GC run, the mass spectrometer began a series of continuous scans at 2 second intervals over the range from 39-500 m/e, terminating only when no further compounds eluted from the GC column.

Total ion chromatograms (TIC) were plotted and quantitative peak-areas were computed for all peaks after establishing appropriate baselines. All TIC peaks were identified from their conventional mass spectra.

2.1.3 Gas Analysis by Mass Spectrometry

The reactor effluent gas sample collected during a microactivity test run was compositionally analyzed using a CEC Model 21-103 MS, low resolution mass spectrometer. Data acquisition and numerical analyses were performed on an IBM PC microcomputer system.

The instrument was programmed to scan mass numbers starting at hydrogen and ending with C_8 hydrocarbons. The results were reported both as received and on a water- and air-free basis which served as a quality assurance test against air leaks.

2.1.4 Coke Analysis

The spent catalyst recovered from a microactivity test run was analyzed for carbon content using a LECO Model CR12 carbon analyzer.

The carbon was reported as a percent of sample from which the total carbon deposited onto the catalyst could be calculated from:

$$M_c = \frac{C_p \times M_{cat}}{100 - C_p}$$

where M_c = yield of carbon in grams
C_p = percent carbon found by analysis
M_{cat} = catalyst charge in grams

2.2 Feedstocks

The pure compounds used as feedstocks during the course of this work were purchased from Aldrich Chemical Company, Inc., Milwaukee, Wisconsin or from Sigma Chemical Company, St. Louis, Missouri. All of the compounds were 99+% pure and were used without further purification.

The three blends A, B and C as well as the pyridine spiked feeds used in Task 3A were prepared gravimetrically from the pure starting material.

2.3 Catalyst

The catalyst used throughout this work was DA-440, a fluid catalytic cracking catalyst manufactured by the Davison Chemical Division of W.R. Grace & Co., Baltimore, Maryland. The DA series of catalyst are manufactured to give high unit retention, superior gasoline and LCO yields, and reduced decant oil yields but moreover, the DA series are intended to have exceptional hydrothermal and thermal stability and to be metals tolerant. In processing heavier materials and residua these latter characteristics are very desirable which made DA-440 a suitable candidate for this work.

Two samples of DA-440 were obtained, the first from Davison Chemical was fresh catalyst while the second sample obtained from the Petro-Canada refinery at Port Moody, British Columbia, was true equilibrium catalyst.

2.3.1 Decoking

The equilibrium sample was decoked before use by first drying the sample at 120°C for two hours in a 180 mm, flat bottom low profile porcelain dish in which the catalyst bed was less than 15 mm thick. At the end of the drying cycle the furnace temperature was increased to 600°C and the door of the furnace left slightly ajar to allow for the circulation of combustion air. The sample was maintained at 600°C for a period of three hours, removing the sample once every hour in order to stir the catalyst using a quartz rod. The decoked catalyst was then removed from the furnace and allowed to cool for five minutes before being placed in a dessicator for storage.

2.3.2 Preparation of Coked Catalyst

Fresh catalyst which had been steam deactivated for five hours was used to crack a conventional gas oil in a MAT unit at 480°C. Six grams of catalyst were used per run while 1 g of feed was injected over a period of 100 seconds. The catalyst bed was recovered and saved while the reactor effluents were discarded. A sufficient number of runs were performed until about 180 g of spent, coked catalyst were removed.

The spent sample was first homogenized by mixing and then regenerated in steps as follows. One third of the sample, about 60 g, were charged to the catalyst steaming apparatus, described in Section 2.3.3. Bed fluidization was maintained with nitrogen only until the unit was at temperature at which point about 20-30% of the fluidization gases were supplied by air. The regeneration was monitored by analyzing a sample of catalyst for carbon every 20 minutes, removed from the top of the unit using a 1-metre, long handled scoop. As the target carbon on catalyst value was approached, the air to the unit was cut back leaving mostly nitrogen. Three samples of spent catalyst were thus regenerated to carbon levels of 0.11, 0.27 and 0.48% from a starting material which had over 1% carbon residue.

2.3.3 Hydrothermal Deactivation

Hydrothermal deactivation of fresh catalyst was performed in an all quartz apparatus at a temperature of 732°C, 100% steam at about 35 kPa. The apparatus, shown schematically in Figure 2.3.1, consisted of a 1.2 m x 30 mm I.D. vertical quartz reactor tube fitted with two heat sources. A coarse porosity quartz frit was sealed into the reactor some 400 mm from the bottom end and served as the catalyst bed support as well as the fluidization gas dispersion system. The zone below the frit was the vaporization and pre-heat section while the zone immediately above the frit was the reactor section.

Heat to the reactor section was supplied by an in-line tube furnace positioned such that the dense catalyst bed would sit in the lower half of the furnace as shown in Figure 2.3.1. Quartz wool was gently packed around the outside of the reactor tube at either end of the furnace to improve heating characteristics and stability by minimizing the cooling effects of convection air.

The lower section served two purposes: 1) to vaporize the incoming water to steam, and 2) preheat the steam or auxiliary fluidization gas to about 500°C before entering the lower portion of the reactor furnace. The section was therefore packed with small 5 mm nichrome saddles as a heat transfer medium and wrapped in Samox fiberglass heating tape (Cole Parmer, Chicago, IL) with an additional external insulating material. The bottom end was sealed and fitted with a nozzle injection system consisting of a pair of co-axial 316 stainless steel tubes as shown in detail in Figure 2.3.1. The outer 6 mm O.D. tube protruded some 50 mm into the packing and served as the inlet for fluidization gases such as nitrogen or air. The inner 1.6 mm O.D. tube projected an additional 50 mm into the packing and served to inject water into the lower portion of the bed for vaporization.

Temperature monitoring was provided by a series of six thermocouples attached to the outer skin of the reactor and positioned such that the lower, middle and upper zones of each section could be measured.

During operation, the catalyst to be treated was loaded to a cold reactor and nitrogen used to fluidize the bed at a rate of from 300 to 400 mL/min depending on the catalyst charge. Catalyst bed heights in excess of 150 mm were found to be unmanageable in this system. The furnace and the pre-heater were both turned on and allowed to reach the desired working temperatures at which point metered water injection was started using a Gilson Minipulse 2 pump. The injection rate was started at about 2 mL/h and slowly increased up to about 20 mL/h ± 1 all the while cutting back on the nitrogen flow until 100% steam was achieved. The catalyst was then allowed to steam for the desired period of time at the set temperature after which the water injection was stoped and nitrogen flow restarted. The furnace and pre-heaters were turned off and the apparatus allowed to cool before the treated catalyst was removed.

2.3.4 Thermal Deactivation

Thermal deactivation was performed in a similar manner to decoking. The period of treatment was considered to start when the furnace reached the set isothermal temperature.

2.3.5 Metals Impregnation

Fresh steam deactivated catalyst were impregnated with various levels of nickel, vanadium and nickel + vanadium using the method described by Mitchell (35). The metals were introduced as naphthenates and the spiked samples treated both hydrothermally and thermally which provides the simultaneous aging of catalyst and metals.

3. RESULTS AND DISCUSSION

3.1 Experimental and Analytical Data

The experimental work was carried out under nine separate tasks and this structure has been maintained herein, each task being presented within a separate section. Only the essential work will be discussed in the report and, similarly, only the successful experimental work and data will be presented. Suffice it to say that most of the microactivity test runs were repeated a number of times in order to obtain the data presented here.

3.1.1 Reactor Effluent Composition

A principal goal of this work was to study the reactor effluent product structure in much greater detail thereby gaining a better understanding of the behaviour and possible interactions between feed, catalyst and catalyst poisons during catalytic cracking. These needs were satisfied by analyzing the reactor effluent gas (REG) and reactor effluent liquid (REL) samples by mass spectrometry (MS) and by gas chromatography-mass spectrometry (GC-MS) respectively. The compositional analysis of the REG and REL were then recalculated on a percent of charge basis using the MAT mass balance and product yield data. Expressed as a percent fresh feed (%FF) the two analyses could then be combined to produce the full reactor effluent compositional yield profile.

For each microactivity test run performed the conventional MAT yield structure is presented. In addition, the reactor effluent compositional yields are also shown for species up to carbon number 17. In a number of cases, the reactor effluent composition was used to produce distribution profiles by hydrocarbon type such as paraffins or aromatics. The numerical profile data was plotted and is presented in graphic format for a large number of the experimental runs discussed in the following sections.

3.1.2 Detailed Analytical Results

The detailed reactor effluent liquid GC-MS results have been tabulated for all of the runs and appear in Appendix I. The numerical values calculated and used in preparing the distribution profile plots were also tabulated and appear in Appendix I as well.

Selected full size distribution plots are presented in Appendix II.

3.2 Task 1 Cracking Yields for Normal Paraffins

3.2.1 Experimental Design

The effects of feed molecular weight upon microactivity product yields were examined using normal alkanes. Three model compounds were chosen which cover the boiling range of typical gas oil feeds. The normal alkanes used were n-octadecane, n-hexacosane and n-dotriacontane with boiling points of 316, 412 and 451°C respectively. The more important physical constants for these feeds are given in Table 3.2.1.

The model feeds were cracked over equilibrium DA-440 FCC catalyst at a standard catalyst to oil ratio of four. Physical and chemical properties of the catalyst are discussed in Section 3.10. In order to establish optimum cracking conditions a systematic study of the effects of cracking severity upon the product yield structure was undertaken.

Reactor temperatures of 450, 475 and 500°C were chosen as the test parameters since this covers the more typical temperature range used to crack and evaluate gas oil feeds. The three model compounds were then cracked at each of the three reactor temperatures specified.

For each feed and for any given reactor temperature, the effects of contact time upon the product yields were studied. Microactivity tests were performed at contact times of 60, 100 and 200 seconds for each feed and again for each reactor temperature.

3.2.2 Microactivity Test Results

Nine microactivity test runs were produced for each of the three molecular weight feeds studied, viz. nC_{18}, nC_{26} and nC_{32}. The MAT product yields for n-octadecane are given in Table 3.2.2 along with the detailed compositional analysis of the total reactor effluent. Similarly, the data for n-hexacosane and n-dotriacontane are given in Tables 3.2.3 and 3.2.4 respectively.

The reactor effluent compositional analysis is not as detailed for Task 1 MAT runs as it is for subsequent tasks. During the early stages of developing the GC-MS analysis of the REL's the group types were reported as saturates, unsaturates and aromatics by product cut rather than by individual carbon number. Therefore the degree to which carbon number distributions could be reported was limited. Speciation of compounds from hydrogen to C_4 was still possible since they were derived from the REG analysis.

3.2.2.1 n-Octadecane

Octadecane is the lighter of the three paraffinic feeds examined. The degree of conversion at various cracking severities is shown in Figure 3.2.1 where conversion values in mass% have been plotted against reactor temperature. Each of the three contact times investigated are represented by a curve on this plot. The numeric data is taken from Table 3.2.2.

At a contact time of 60 seconds conversion increased quickly with reactor temperature over the range studied. A similar behaviour was observed for the 100 second contact time data with the entire curve displaced to higher conversion values. But when a 200 second contact time was used, very little change in the conversion value over the reactor temperatures examined was noted. This last curve was nearly flat at conversion values of 95 to 97 mass%.

That cracking severity increases with both contact time and temperature was apparent from the plots in Figure 3.2.1. The 200 s contact time data clearly showed that increasing the cracking severity beyond this point had little advantageous effect. This curve in essence sets a quasi-upper limit to the conversion of octadecane for the catalyst used and the temperature range studied. Conversion values obtained with a 100 s contact time increased rapidly with temperature and at 495°C had nearly reached the upper limit of conversion for octadecane. The 60 s contact time led to a low severity cracking of octadecane over the range of temperatures used and even at the higher temperature, conversion was still well below the maximum attainable.

The combinations of contact times and temperatures investigated covers a wide range of cracking severities for octadecane. At a contact time of 60 s and a reactor temperature of 450°C, conversion was on the low end at some 56% while at the higher temperatures of 500°C and contact times of 100 s or more conversions were generally greater than 95%.

In most cases high conversion does not lead to an optimum product yield structure. Because of side reactions and secondary reactions which occur at higher cracking severities the products generated may not be the desired ones. At some point on the temperature scale, the degree of thermal cracking will become significant relative to the amount of catalytic cracking. In addition, a special situation exists where the primary products of catalytic cracking undergo secondary and tertiary cracking reactions because the severity is too high. This leads to poor gasoline and distillate yields and very high yields of C_3 and C_4 hydrocarbons and is referred to as "overcracking".

The data in Table 3.2.2 shows a trend towards higher yields of C_3C_4 material at higher reactor temperatures and also with longer contact times. The data was plotted in Figure 3.2.2 where these trends are more easily seen. The yield of C_3C_4 material increased sharply with temperature for both 60 s and 100 s contact times. At 200 seconds the slope of the curve was not as steep although the yields of C_3C_4 were significantly higher than those obtained at shorter contact periods.

The C_3C_4 data holds no significant information regarding the optimum cracking conditions necessary to maximize transportation fuel production. Optimum cracking parameters can be defined in terms of maximum gasoline yield or maximum gasoline plus distillate (LCO). For the purpose of this discussion, C_5+ gasoline yield was chosen as the basis for defining optimum cracking conditions.

The yield data given in Table 3.2.2 for C_5+ gasoline have been plotted in Figure 3.2.3. The dependence of the gasoline yield upon both contact time and reactor temperature was quite evident from the graphs. At a contact time of 60 s C_5+ gasoline yields go through a maximum of about 47% at a temperature of some 483°C. A 100 s contact time led to a maximum at a slightly lower temperature of 478°C but the maximum yield was far greater at 58%. The curve at a 200 s contact time did not go through a maximum but rather showed a decrease in gasoline yield with increasing temperature. That is because the maximum occurred at a temperature inferior to 440°C. Although octadecane was overcracked at contact times of 200 s, over the temperature range examined, it is important to consider the magnitude of the gasoline production. For example, the yield of C_5 and gasoline at 450°C and a 200 s contact time is equivalent in magnitude to the maximum obtained for the 100 s contact time runs. This is to say that the gasoline maximum is sensitive to reactor temperature and contact time individually.

The magnitude of the C_5+ gasoline yield maximum appeared to decrease with increasing temperature in the range of 450 to 500°C. The maxima also shifted to progressively lower temperatures as the contact time increased through the series 60, 100 and 200 seconds.

There existed for octadecane a relationship between the maximum gasoline yield and the rate of disappearance of the feed as seen from the data plotted in Figure 3.2.4. While the slope of the LCO curve remained steeply negative, indicating a high rate of disappearance of the feed, the gasoline profile, Figure 3.2.3, increased steadily. When the yield of LCO levelled off, the rate of gasoline formation also levelled off. Beyond this point the rate of overcracking becomes more important than the rate of gasoline formation. This situation leads to a maximum in the gasoline profile. The temperature of the gasoline maximum was observed to occur at 5 to 6°C higher than the extrapolated end of conversion temperature for LCO, see Figure 3.2.4.

According to the Voorhies (27) equation coke yield should increase with both temperature and contact time. Figure 3.2.5 shows the coke yield data for octadecane and indeed the coke yield does increase with both contact time and reactor temperature. Octadecane yields about one-half the amount of coke when compared to typical gas oils under identical conditions.

3.2.2.2 n-Hexacosane

Hexacosane is representative of paraffins in the middle of the boiling range for typical FCC feeds. The MAT yield data for hexacosane are given in Table 3.2.3.

The conversion data plotted in Figure 3.2.6 were seen to cover a range not unlike that of octadecane. At a contact time of 60 s, conversion increased rapidly with temperature. But at contact times of 100 and 200 s conversion was nearly independent of temperature since the curves were almost flat. The effects of increasing contact time was clearly shown by the spacing betweeen the three curves. At contact times of 100 s or more, conversion was already at 90% or greater, therefore there is little to gain in increasing the cracking severity beyond this point.

The yields of C_3C_4 product behaved in the expected manner. The yields increased sharply with temperature and also with contact time.

The conversion data in Figure 3.2.6 indicated that at contact times of 100 s or more hexacosane was severely cracked at temperatures of 450 and above. This observation does indeed hold true as seen from the C_5+ gasoline data for hexacosane plotted in Figure 3.2.7. At both 100 and 200 s contact times the gasoline maximum appeared to occur at temperatures below 450°C. At the lower severity 60 s contact time, a gasoline maxima occurred near 478°C.

The level of conversion of the original feed was very high at the cracking severities studied, The degree of hexacosane cracking is shown graphically in Figure 3.2.8 where LCO and DO yields are plotted. Only at the 60 s contact times was there any significant amount of LCO and DO shown.

The coke yields are plotted Figure 3.2.9 and are seen to increase with both temperature and with contact time. Coke make from cracking hexacosane was only slightly higher than for octadecane. The yields were still well below those expected from cracking typical gas oils.

3.2.2.3 n-Dotriacontane

The upper limit for a typical gas oil cut is around 540°C which places n-Dotriacontane in the third quarter of the gas oil boiling range. The MAT yields are presented in Table 3.2.2 from which the conversion data shown in Figure 3.2.10 were taken.

The degree of conversion was high even for the least severe cracking conditions of 450°C and 60 s contact time. Conversion at 100 s or greater contact time was virtually independent of temperature since it had topped out.

Overcracking of hydrocarbon feedstocks over zeolite catalysts leads to high yields of low molecular fragments in the C_3C_4 range. This was observed for dotriacontane, with yields of C_3C_4 in the 25 to 35% range. The yields should also have increased with temperature and contact time and they did in all three cases.

The overcracking of dotriancontane was most evident from the gasoline yield data, Figure 3.2.11. For each of the three contact times studied the gasoline yields gave negatively sloped curves over the temperature range used. Therefore, the gasoline maxima occurred at lower cracking severities than those which were studied here.

The yields of LCO and DO were small indicating severe cracking of this particular feedstock, Figure 3.2.12. Moreover the yield profiles at 100 and 200 s contact times were nearly horizontal and therefore independent of temperature which indicates cracking had topped out.

Dotriacontane had the highest yields of coke of any of the paraffins but they were still below the coke yield from a typical gas oil feed. Figure 3.2.13 shows of the coke yields obtained for dotriacontane.

3.2.3 Standard Cracking Parameters

Hydrocarbons of different classes such as alkanes, cycloalkanes and aromatics behave quite differently when cracked over a given catalyst at some fixed set of conditions. One of the objectives of Task 1 was to study the effect of molecular weight on a very specific class of compounds, the n-alkanes. In addition the MAT data obtained over a wide range of cracking severities would be used to establish standard cracking parameters to be used in all other studies herein.

The standard parameters were to cover a short range of cracking severities such that most feedstocks would be moderately undercracked, optimally cracked and slightly overcracked. The C_5+ gasoline yield was chosen as the measure of cracking optimization rather than the total gasoline plus distillate (G+D) yield. Although the latter represents the total yield of transportation fuels (with the exception of alkylate), it was not used as the optimization factor since many of the feedstocks used would fall within the boiling range of LCO. Therefore any unconverted feed would have resulted in an erroneously high yield of transportation fuels at low conversion levels.

The parameters chosen for optimization based on C_5+ gasoline yield were a given reactor temperature and three different weighted hourly space velocities (WHSV). Since the catalyst-to-oil ratio was fixed at 4, the variable factor would be contact time. Therefore a fixed reactor temperature and three contact times were chosen as described here.

The paraffin feedstocks were cracked at three contact times for each of three reactor temperatures. Microactivity conversions were plotted against feed molecular weight at each of the reactor temperatures studied, Figure 3.2.14. At a reactor temperature of 450°C and a contact time of 60 seconds, conversion increases rapidly with increasing molecular weight. This same trend can be observed at 475 and at 500°C which establishes the order for ease of cracking as $C_{32} > C_{26} > C_{18}$.

The majority of compounds cracked during this program had a molecular weight close to that of octadecane. In view of the dependence upon molecular weight of the crackability of a feedstock, octadecane was selected as the test criteria for setting the optimum cracking parameters. Plotting mass% yield of C_5+ gasoline against WHSV for octadecane gave the yield profiles shown in Figure 3.2.15. The maximum yield of gasoline appears to occur at a temperature close to 475°C while at 450 and 500°C the material is undercracked and overcracked respectively with regards to maximum gasoline. Reactor temperature was thus selected to be 477.5°C ± 2.5°C, or within the range of 475 to 480°C.

With the reactor temperature fixed, WHSVs could now be chosen such that they would properly define the gasoline maximum. Using these criteria, WHSVs of 4, 7.5 and 15 were selected. With a catalyst to oil fixed at 4, then the WHSVs selected represented contact times of 200, 120 and 60 seconds, corresponding to the values given above.

3.2.4 Molecular Yields

3.2.4.1 Product Cut Points and Hydrocarbon Distribution

Microactivity yield structures are typically reported as product cuts viz., H_2-C_2, C_3C_4, C_5+ gasoline, light cycle oil, decant oil and coke. Product cuts are delimited by an upper and lower boiling point. For the lighter product cuts this is sufficient to allow for the segregation of products into carbon number groups. These are the C_1-C_2 and C_3C_4 product yields. The gasoline cut is well defined at the bottom end, starting at C_5, but is not so well defined at its upper end. The standard cut point for gasoline is 221°C and would therefore include alkanes and most alkenes to C_{12}. Alkylcycloalkanes would only be included up to C_{11} as would most alkylbenzenes. Decaline type compounds would be partitioned at C_{10}-C_{11} depending on the substitution as would most tetraline and indane type compounds.

Diaromatics are at the very top of the gasoline boiling range with naphthalene (C_{10}) while any substituted naphthalenes are not included within the gasoline range by definition. The gasoline end point carbon number is therefore dependent on composition and lies between C_{10} and C_{12}. For the purpose of this work, the gasoline range was defined as being C_5 to C_{11} compounds. The carbon number range for light cycle oil would then start at C_{12} and end at C_{19} which sets the decant oil range as C_{20}+.

3.2.4.2 Reactor Effluent Composition

From the detailed compositional analysis of the MAT REGs and the group type analysis of the RELs, it is possible to produce a hydrocarbon type distribution by carbon number for the entire MAT reactor effluent. It then becomes possible to appreciate the data systematically in a manner which more fully exploits the MAT technique. The advantage is a better understanding of the catalytic cracking process through simple, inexpensive and relatively quick MAT studies.

On Tables 3.2.2 through 3.2.4 are presented the condensed reactor effluent compositional data for n-C_{18}, n-C_{26} and n-C_{32}. The data in these tables are subsets of the unrefined compositional information attached as Appendix I. The results presented in the Tables 3.2.2-3.2.4 were analyzed in various ways as described here.

3.2.4.3 Carbon Number Distribution

The reactor effluent carbon number distribution from C_1 through to the end of the gasoline range is shown for n-C_{18} in Figure 3.2.16. The data is presented as sets of molecular yields at different contact times for a given reactor temperature. The overall profile was very consistent at any given temperature; rising quickly from C_3 to peak at C_4 then decaying slowly down through to the end of the gasoline range.

This as not the profile expected from simple one-bond cracking of the parent feedstock. It represented what would be expected from multistage catalytic cracking through predominantly carbonium ion mechanisms over zeolite catalysts.

A number of phenomena occur as the cracking severity was increased. The most evident was the disappearance of the C_{14}^+ peak as a result of higher feed conversion. This occurred with both increasing contact times and with increasing reactor temperature. The C_{14}^+ peak in this case was essentially the feed as there were very little C_{14} to C_{17} compounds identified in the reactor effluent. The large amount of C_{18} material found was indeed the starting feed.

Increasing cracking severity also affected the yield of material at any given carbon number. For C_3 and C_4 compounds the effect was unidirectional in that increasing the cracking severity increases the yields of these species. The C_3 and C_4 compounds are therefore both primary and secondary products of catalytic cracking. Once formed, they did not crack further as substantiated by the virtual nonexistence of C_1 or C_2 compounds. These latter species are not highly favoured by carbonium ion reaction chemistry and therefore did not appear as the result of zeolitic cracking. They do occur as a result of nonselective thermal cracking which is why their yields are more sensitive to reactor temperature than to contact time.

The compounds from C_6 through C_9 behaved in a different manner from that of the C_3 and C_4 species. As cracking severity increases (contact time or temperature), the yield of these compounds also increased as long as there remained sufficient unconverted feed at which point a maximum was attained. Beyond this point overcracking predominated and the yields decreased. Moreover the entire yield profiles, Figure 3.2.16, showed a gradual shift to lighter products as the cracking severity increased. The ultimate products of overcracking octadecane appeared to be C_3, C_4 and C_5 compounds formed at the expense of the C_6 to C_9 fractions.

The behaviour of the C_5 material with cracking severity was not straight forward. At the lower temperatures the C_5s behaved in a manner similar to the C_3 or C_4 compounds. But at 500°C, this behaviour was lost as C_5 yields become independent of contact time.

Compounds in the C_{10} to C_{15} range did not at first appear to trend in any given manner except that their overall yields were small relative to the C_3 to C_9 compounds. There was a definite increase in the yield of higher carbon number species as contact time increased at any given reactor temperature. This point will be examined further when group types are discussed in the following section.

The general trends and behaviours in the carbon number distribution profiles of octadecane ere also observed for hexadecane (Figure 3.2.17) and dotriacontane (Figure 3.2.18). During this early work, GC-MS analysis of the reactor effluent was reported by product cut rather than by individual carbon numbers. Therefore C_5 to C_{11} compounds were not available as individuals. The is-d appearance of the feed and overcracking effects were nevertheless obvious for either C_{26} or C_{32} feeds from Figures 3.1.17 and 3.2.18. The marked increase in C_3 and C_4 compounds with increasing severity was readily appreciated as was the paucity of the C_1 and C_2 materials.

3.2.4.4 Hydrocarbon Type Distribution

The level of detailed speciation reached during this work goes beyond simple carbon number distribution. The cracking behaviour of n-alkanes was further defined by examining the hydrocarbon group types for any given carbon number. For example, the data in Tables 3.2.2, 3.2.3 and 3.2.4 were numerically analyzed to produce carbon number distributions for the paraffins, olefins + cyclos and the aromatics found in the reactor product. This data is best presented graphically and appears in bar format in Figures 3.2.19-3.2.21 for octadecane at reactor temperatures of 450, 475 and 500°C respectively.

Saturate compounds were by far the major products of cracking n-octadecane. Average product distribution into saturates, unsaturates, aromatics and coke would be about 63, 25, 10 and 2% respectively. The paraffins produced are not straight chained but rather the result of isomerization/rearrangement, polymerization or disproportionation. From the raw data in Appendix I, Task 1, it can be seen that the C_4 paraffins are composed mainly of i-butane rather than n-butane. The C_4 average iso to normal ratio was calculated to be about 2.5. Similarly the branched pentanes were in much larger proportion than the straight chained compound where the ratio of branched to normal was found to be of the order of 4.

The overall profile of the paraffin yields for the C_6 to C_{11} compounds changed slightly with contact time and even less with temperature. The magnitude of these yields did vary with cracking severity and were very sensitive to overcracking. Moreover, the selectivities of the individual paraffins were fairly constant when overcracking was not appreciable. Therefore the paraffins in the gasoline were sensitive to overcracking.

The C_5 paraffins behaved differently in that there appeared to be a maximum yield attainable at about 14 or 15% and the yields appeared to be more contact time dependent than temperature dependent. Once formed, the C_5 paraffins were stable and did not crack significantly into smaller fragments as evidenced by the lack of any significant amounts of methane, ethane or ethene.

Of the propane and butanes, only the C_4 paraffins were produced to any great extent. The former became significant only at high cracking severities and was therefore a product of overcracking. Butanes were significant products of cracking and of overcracking as their yield increased open-endedly.

Olefins, cycloparaffins and cycloolefins comprised the next major yield group. The predominant members of this series were propene and the butenes and they were the only members whose yields increase with increasing cracking severity. The C_3 and C_4 olefins were major products expected from carbonium/carbenium ion cracking from Bronstead and Lewis acid catalytic sites. Since C_5 and heavier olefins are reactive and will tend to rearrange with hydrogen transfer, it was not surprising to see their yields decrease with cracking severity.

Normal alkanes can, by a series of steps which include formation of a cycloalkane followed by dehydrogenation, produce aromatic structures when reacted over zeolitic catalysts. Aromatics are stable structures and are therefore highly refractory and difficult to crack once formed relative to the parent compounds. The aromatics represent final products of cracking and should therefore increase in yield as conversion increases and they should be relatively insensitive to overcracking. The data for octadecane shown in Figures 3.2.19-3.2.21 agree with the foregoing. The overall yield of aromatics rose with increasing cracking severity and especially contact time. The major species were C_8 and C_9 alkyl benzenes and naphthalene. As the severity increased, the diaromatics were favoured over the monoaromatics. Traces of triaromatics and tetraaromatics were also found which indicates condensation reactions.

Octadecane when cracked produced from 1.7 to 3.4 mass% coke over the range of cracking severities examined and was sensitive to both contact time and reactor temperature. Assuming a hydrogen to carbon ratio of one in the coke then the amount of hydrogen liberated during coke formation would be 1/13 of the coke. Octadecane would produce from 0.17 to 0.25 mass% hydrogen in this case. Added to this would be the hydrogen liberated from cycloparaffins, olefins, cycloolefins and aromatics. Taking into consideration all of these factors gives an expected hydrogen yield of the order of 0.7 mass%. The actual yields were a full order of magnitude lower. Hydrogen as such was not liberated during the cracking process but through protolitic cracking mechanisms and efficient hydrogen transfer most of the hydrogen remained as part of the hydrocarbons. This in part explains the large amount of saturate material found in the reactor effluent.

Similar data is presented in Figures 3.2.22 through to Figure 3.2.27 for n-hexacosane and n-dotriacontane. Although the gasoline range compounds were not broken out by individual carbon numbers, the major trends observed for n-octadecane were also observed for n-hexacosane and n-dotriacontane.

The cracking severity required to achieve the almost complete disappearance of the feed was found to be substantially less for for C_{26} and less again C_{32} relative to C_{18} as evidenced by the C_{20}^{+} paraffin peak. The yields of C_1 to C_4 paraffins behaved in a similar fashion for all three feeds as did the gasoline range products.

All three n-alkanes cracked in a very similar fashion with predictable reactor effluent composition.

3.2.4.5 Cracking Severity and Product Quality

Taken separately the hydrocarbon group type analyses reveal a significant amount of information concerning the compositional changes which occur in the product cuts as the parameters for cracking are varied. The following discussion will use the compositional trends identified in Section 3.2.4.4 to show the effects of cracking severity upon the composition and hence quality of the product cuts.

Fuel gas was a minor product of paraffin cracking. At low cracking severity the product was highly paraffinic being mostly methane and ethane. At higher reactor temperatures and longer contact times the stream became almost a third ethene by weight with an accompanying rise in hydrogen content.

The composition of the C_3C_4 Product stream is important to the refiner because it is the raw feed to the alkylation unit. The yields of total C_3 and C_4 were seen to increase with increasing cracking severity for all three feeds. The C_3s were mostly olefinic (propene) while the C_4s were mostly paraffinic (i-butane). With increasing temperature the C_3 to C_4 ratio increased as did the overall olefinicity due to both propene and the butenes. With increasing contact time the paraffinicity increased slightly, mostly due to i-butane with lesser contributions from propane and butane. Increasing the contact time did not seem to effect the C_3 to C_4 ratio as much as temperature. Therefore higher temperatures resulted in higher yields of olefins but with an accompanying reduction in the i-C_4 to olefins ratio.

The gasoline cut is by far the more important one to refiners in terms of yields and quality. In Section 3.2.4.5 it was clearly demonstrated that overall yields of C_5+ gasoline were very dependent upon cracking severity. But it was also shown that the total olefin content decreased with increasing cracking severity which is good since olefins are the precursors for gum and varnish. On the other hand, olefins contribute to a higher octane rating. This loss in octane is more than offset by a large increase in the total aromatics content of the gasoline. The monoaromatics make a significant contribution to the octane value. Therefore as cracking severity increased, the quality of the gasoline increased due to a higher octane rating and a lower gum forming tendency. But the volumetric yields were severely dependent on both temperature and contact time.

The light cycle oil product stream can be hydrogenated to make distillate fuels. In the case of n-C_{26} and n-C_{32} the quality of the LCO deteriorates as cracking severity increases due to the decrease in paraffinicity with an accompanying increase in aromaticity. The product is therefore more difficult to hydrogenate.

There are many factors which influence not only the magnitude of the yields from catalytic cracking but also the product quality.

It is here that the catalyst plays its greatest role; in determining product selectivity and product quality. The compounds chosen as molecular probes should therefore be sensitive to one or more of the catalyst's properties such as octane enhancement, fuel gas selectivity, coke make etc. This section has shown that n-paraffins are good gasoline producers with low fuel gas and coke makes. They give information on hydrogen transfer capabilities as well as the ability of the catalyst for aromatics formation in the gasoline and LCO range.

3.2.5 Effects of Molecular Weight

For the n-alkanes as feedstocks the greatest effect of molecular weight was found to be the ease of cracking. Dotriacontane showed a much higher level of conversion at a given cracking severity than did hexacosane and even more so again compared to octadecane, The information contained in Figure 3.2.14 leads directly to the conclusion that the n-alkanes can be ranked as to ease of cracking and that the order would be $C_{32} > C_{26} > C_{18}$. This is as would have been predicted from studies of homologues short-chain paraffins (28,29) which showed that the length of the chain has an influence on the activation energy of the cracking reaction.

The compositional makeup of the product did not appear to change with the molecular weight of the feed although the total gasoline yield followed the order of cracking. Dotriacontane made more C_5^+ gasoline than did hexacosane which in turn had higher yields than octadecane. The overall composition of the gasoline was similar in all three cases.

Coke make was affected by feed molecular weight. The heavier feeds produced more coke.

3.3 Task 2 Cracking Yields for Other Hydrocarbons

3.3.1 Experimental Design

Fluid catalytic cracking units feed from gas oils derived from numerous sources. These may include conventional crudes, synthettic crudes and also gas oil streams which originate from other refinery processes such as visbreaking, propane deasphalting, coking and hydroprocessing to name a few. One common factor between these diverse feed streams is the complexity of their composition, being made up of numerous hydrocarbon types. Some of the major types found in these streams are paraffins, cycloparaffins, aromatics and benzocycloparaffins. Thermal processes such as visbreaking or flexicoking also yield olefinic structures not present in naturally occurring crudes.

A better understanding of the catalytic cracking of gas oils and the role of the cracking catalyst would be gained by studying the cracking patterns of selected members of these hydrocarbon types. Seven compounds representing branched paraffins, olefins, cycloparaffins and aromatics were selected to represent the various hydrocarbon types. The model feeds chosen are listed in Table 3.3.1.

The feeds were cracked in a MAT apparatus at a reactor temperature of 480°C and at a fixed cat/oil ratio of four. The catalyst was equilibrium DA-440; sample XC013DE. Three runs were performed on each model feed using each of the standard contact times discussed in Section 3.2.3, viz. 60, 120 and 200 seconds. The REGs and RELs were compositionally analyzed as before.

3.3.2 Experimental Results

Microactivity test yield structures are presented in Table 3.3.2 for all seven feeds studied. Detailed reactor effluent compositions are also shown for each feed based on a % fresh feed. The actual raw data is to be found in Appendix I.

The cracking patterns for each of the feeds studied are discussed in the following sections. Carbon number distributions are given for the total reactor effluent as well as the paraffins, naphthenics and the aromatics.

3.3.2.1 2,6,10,14-Tetramethylpentadecane

A member of the alkane family, 2,6,10,14-tetramethylpentadecane (TMPD) is representative of the branched paraffins. The compound is an excellent molecular feed since it is representative of a group of compounds which make up a large portion of many typical gas oils from Canadian crudes. Moreover, 2,6,10,14-tetramethylpentadecane, also known as pristane, is one of a pair of hydrocarbon "bio-markers" found in virtually all world crude oils.

The MAT yields for TMPD presented in Table 3.3.2 show the feed to be very easily cracked with a high selectivity towards gasoline. The conversion values were extremely high owing to the complete lack of any decant oil and only a token amount of light cycle oil. This feed, like other paraffins, did not produce a significant amount of coke. The gasoline range material was sensitive to overcracking as evidenced by the sharp drop in C_6^+ gasoline at the higher cracking severity.

The cracking patterns for TMPD are presented graphically in Figure 3.3.1. The large yield of C_5^+ gasoline was evident from the reactor effluent carbon number distribution. Moreover, the species within the gasoline range were well apportioned throughout the carbon numbers. The non existence of any significant peaks beyond C_{12} confirmed the very high conversions observed from MAT data alone. Average overall yields of paraffins, naphthenics and aromatics were 56, 24 and 16% FF respectively.

The reactor effluent was found to exhibit a bimodal carbon distribution. The first ranged from C_3 to C_6 while the second covered the C_6 to C_{11} compounds. The former was characteristic of catalytically cracked material and due mainly to the smaller stable fragments expected from zeolitic cracking, viz. C_3-C_5 olefins and isoparaffins. The second mode came from an accentuation of the paraffins in the C_7 to C_{10} range which was not manifested when cracking straight chained paraffins. The favouring of the C_7 to C_{10} compounds can be traced to the molecular structure of the feed. The molecule of 2,6,10,14-tetramethylpentadecane has four tertiary carbon centers which favour carbenium ion formation and protolytic attack. The molecule is also symetrical at carbon 8 which reduced the number of major products expected. From a protolytic mechanism or carbonium ion approach, the formation of paraffinic fragments in the C_7 to C_{11} range are easily explained when preferential attack is made at carbon positions 2, 6, 10 and

14 in the original feed molecule. In particular, catalytic attack at carbon 6 to produce a carbenium ion would, if β-scission at carbon 5 takes place, lead to the formation of i-pentane directly. A similar attack at carbon 14 with β-scission at carbon 15 leads to the same product since the molecule is symetrical. The yield of i-pentane is in fact relatively high as seen from the compositional data, Table 3.3.2.

The C_6 to C_{11} aromatics featured a profile not unlike that of the n-paraffins in both distribution and magnitude although the overall yield of aromatics was higher for TMPD. The increase was mostly due to the higher molecular weight aromatics and in particular the C_{12}+ fraction. The molecular structure of the feed having tertiary carbons at positions 2, 6, 10 and 14 allows for an increased possibility of ring formation to give both mono and diaromatics.

The patterns obtained from cracking TMPD are similar to those observed from n-alkanes except for the anomalies discussed above. The low hydrogen yield and high paraffin yield is indicative of efficient hydrogen transfer. Branched chained paraffins are excellent gasoline producers for which the quantity and quality of the gasoline appears to be superior compared to that obtained from n-paraffins.

3.3.2.2 1-Octadecene

A member of the alkene family, 1-octadecene ($C_{18}^{=}$) is representative of the unsaturated aliphatic materials common in gas oils derived from heavy ends upgrading such as visbreaking or coking.

The MAT yields for $C_{18}^{=}$ presented in Table 3.3.2 show the feed to be easily cracked with a high selectivity towards gasoline. The conversion values are very high due to the moderate to low LCO make and the very little DO produced. This feed, unlike the paraffins, produces a moderate amount of coke and hydrogen. The gasoline range material is nearly insensitive to overcracking as seen from the stable C_6+ gasoline yields.

The cracking patterns for $C_{18}^{=}$ are presented graphically in Figure 3.3.2. The gasoline range material yields are not unlike those for branched chain paraffins in both magnitude and distribution as seen from the reactor effluent carbon distribution plot.

Upon closer examination of the paraffinic, naphthenic and aromatic distributions the similarities between octadecene cracking and paraffin cracking disappear. The overall yield of paraffins is of the order of 39% for octadecene while TMPD produced some 56% saturates and octadecane gave 62%. The front end members are the most noticeably reduced.

The distribution and behaviour of the naphthenic products are similar when compared to those obtained with paraffinic feeds although the magnitude of the yields are different. Octadecene produced about 32% cyclos + olefins while the paraffinic feeds gave only 24%.

The cracking of octadecene yields a significant amount of aromatic products relative to saturate feeds. Total aromatics were found to be 25% FF for octadecene which is nearly twice the amount obtained from n-paraffin cracking.

The gasoline range material obtained from olefin cracking differs in composition from that produced when cracking paraffinic feedstocks. The gasoline tends to be more naphthenic and significantly more aromatic which would increase its octane value. The insensitivity of the gasoline range material to overcracking is mostly due to the large content of aromatics and the lack of significant amounts of C_8+ paraffins.

The aromatic species are also responsible for the LCO and DO yields observed. There are no C_{13}+ paraffins and less than 0.5% unconverted feed above C_{13}. The aromatic species found throughout the reactor effluent and the higher coke make are consistent and show the aliphatic olefins to have a higher propensity towards aromatization.

3.3.2.3 1,3,5-Triisopropylcyclohexane

A member of the cycloalkane family, 1,3,5-triisopropylcyclohexane (TIPCH), is representative of the alkyl substituted cycloparaffins. Monocycloparaffin content in gas oils cut from typical Canadian crudes is in the range of from 12 to 16%. Therefore triisopropylcyclohexane is an appropriate model compound.

The MAT yields for TIPCH are given in Table 3.3.2 and show the feed to be easily cracked as conversion values were extremely high at 96%. The major products were gasoline range material and these were not very sensitive to overcracking as evidenced by the C_6+ gasoline yields. The coke make was found to be very low compared to the already low coke makes for the paraffins.

The cracking patterns determined for TIPCH are presented graphically in Figure 3.3.3. The reactor effluent product distribution by carbon number was found to be not unlike those seen for the paraffins. From the molecular structure of triisopropylcyclohexane it would not be difficult to rationalize high yields of C_3, where in fact the C_3 yield was found to be similar to those obtained from paraffin cracking. The yield of C_4 products and not C_3 was actually the one observed to have increased over the expected value.

The cracking of TIPCH yielded three times the amount of propane than had the paraffinic or olefinic feeds. But at a yield of about 3%FF it was still not significant. The majority of the C_3 product was found as propene and at levels below those found in the case of paraffin feeds. The yield of butenes were expected to be lower than the propenes and they were; but by the same reasoning, so were the anticipated yields of butanes, but they were not. The yields of butanes were, in fact, twice the value obtained from cracking aliphatic paraffins. Moreover, the split between n-butane and i-butane was calculated at 13% and 87% respectively. The i-butane was therefore selectively enhanced at the expense of the C_3.

Triisopropylcyclohexane did not produce a significant amount of C_6+ paraffins as expected although the total paraffins recovered amounted to 45%FF. Clearly half of that was attributed to the enhanced butanes yield.

The yields of cyclos + olefins were measured at fairly low values considering the nature of the feed. Total naphthenic yield was calculated at 17% of charge.

The aromatic distribution showed a nearly bell-shaped pattern centered at C_9-C_{10}. The lower molecular weight aromatics appeared to originate from the dealkylation of the heavier aromatics with increasing cracking severity. The total amount of aromatics produced at any given contact time did not differ appreciably except in the low conversion case. This suggests that aromatic formation was rapid in this case and gave about 34% yield on charge.

The composition of the gasoline fraction obtained from cracking triisopropylcyclohexane was determined to be 50% aromatic, 30% paraffinic and 20% naphthenic. The gasoline in this case would therefore be superior to the gasolines obtained from cracking either the paraffinic or olefinic feedstocks. Given the composition of the C_5+ gasoline it is easily seen why it is not subject to serious overcracking.

In view of the total amount of aromatics formed during triisopropylcyclohexane cracking it is surprising to see such low yields of hydrogen. The rate and effectiveness of hydrogen transfer in this case are high which in turn supports in part the abnormally large yields of the saturated aliphatic i-butane.

In opposition to the trend found for octadecene, triisopropylcyclohexane has a large propensity for aromatic production but did not show the same tendency for coke make.

3.3.2.4 1,3,5-Tri-t-Butylbenzene

A C_{18} monoaromatic, 1,3,5-tri-t-butylbenzene (TTBB) is a member of the alkylbenzenes. Alkyl substituted monoaromatics are found in both conventional and synthetic gas oils as well as in gas oil fractions from processed heavy ends.

Based on MAT data, tri-t-butylbenzene was observed to be a poor gasoline producer although the conversion values calculated were extremely high. The feedstock cracked to C_6+ gasoline and C_3C_4 material almost exclusively. The yields of fuel gas and of C_5 were the lowest recorded for any of the model feedstocks studied with the exception of the fluorenes.

In view of molecular structure of this feed it was not surprising to see the cracking pattern and carbon distribution shown in Figure 3.3.4. Significant amounts of product were observed at C_4, C_6 and C_{10} within the reactor effluent profile from the cracking of tri-t-butylbenzene.

The C_4 products were identified as a mixture of butanes and butenes. The butanes were further speciated and shown to consist almost exclusively of i-butane. It was also noted that at short contact times the butenes predominate but as contact time increased the butenes decreased. Neither the paraffin or the naphthenic profiles showed any significant amounts of the products expected from butene polymerization. But there was a strong correlation between the amount of butene consumption and i-butane appearance suggesting saturation of the butenes by hydrogen transfer to give i-butane. This also suggests that the butene in question would have been 2-methyl-1-butene since no significant amount of n-butane was found.

The profile found for the distribution of aromatic species showed a classic dealkylation mechanism. The major aromatic products observed were benzene and a C_{10} alkylbenzene which was most probably t-butylbenzene since no naphthalene compounds were detected.

Low molecular weight alkyl substituted benzenes tend to dealkylate and little else (30).

3.3.2.5 1-Phenyldodecane

A C_{18} monoaromatic, 1-phenyldodecane (IPC12) is representative of the alkylbenzenes. Although the molecule is nearly 65% paraffinic in nature, the aromatic ring should have a dominant effect upon the gasoline range products.

Phenyldodecane cracked to produce significant amounts of gasoline material at low severity and moderate amounts at high severity operation. The conversion values calculated from MAT data alone tend to show that phenyldodecane is difficult to crack when in fact it is not. This subject is discussed later in connection with the detailed reactor effluent analysis. Relative to the paraffinic feedstocks, phenyldodecane produced typical yields of fuel gas and coke. However, the yields of C_3C_4 were observed to be low while the LCO and DO were the highest recorded of any of the hydrocarbon feeds.

The reactor effluent carbon number profile for phenyldodecane cracking exhibits a characteristic C_1 to C_4 front-end, Figure 3.3.5. The gasoline range material displayed a typical pattern when compared to aliphatic or cycloparaffinic feedstocks. The molecular yields were found to increase slightly with increasing carbon number which gave the gasoline profile an almost rectangular shape with a noticeable accentuation at carbon numbers C_9 to

C_{11} relative to the paraffinic feeds. The heavy ends profile was typical although the magnitude of LCO and DO proved to be substantially more than observed for all other crackable feedstocks studied. The model feed was not detected in the reactor effluent as evidenced by the C_{18}^+ material found. Therefore the low conversion values obtained from MAT experiments do not reflect the crackability of phenyldodecane but rather its propensity in producing substantial amounts of LCO + DO.

Total paraffin yields averaged 40% on charge and were found to be mostly in the gasoline range material. Owing to the shorter paraffin chain length of the parent feed and the tendency towards aromatization of the side chain, the yields of butanes are lower than expected, mostly due to the absence of i-butane.

The naphthenic portion of the reactor effluent averaged out at 9% FF, the lowest recorded yield of any of the crackable feedstocks studied. Propene accounted for a third of the total while butenes and the C_7-C_8 Products accounted for the remainder. Of note is the sharp cut-off in the naphthenic profile at C_8 which would tend to indicate dealkylation or β-scission of the paraffin side chain once diaromatization had taken place.

The reactor effluent contained some 45%FF aromatic products of which more than two-thirds were found to be diaromatics, i.e. naphthalene and indane based. These latter compounds were the source of the high yields of LCO and DO.

Phenyldodecane does not behave as part paraffin and part aromatic. The influence on the cracking pattern of the aromatic moiety is substantial and leads to the aromatization of the paraffinic side chain rather than simple dealkylation.

The gasoline fraction from cracking long chained alkyl substituted benzenes was found to be paraffinic with a large aromatic contribution and relatively non-naphthenic. The product would therefore have a high octane value and show little tendency towards gum and varnish production.

The degree of aromatic condensation observed for phenyldodecane was relatively severe which would therefore produce a significant amount of hydrogen. The product structure revealed some hydrogen but not in the quantities expected. The paraffinic nature of the reactor effluent and the low naphthenic yields suggests a high level of hydrogen transfer activity.

Although 1-phenyldodecane cracks to yield high levels of diaromatics it was not observed to produce significantly more coke than other feedstocks examined, cf octadecene, Section 3.3.2.2.

3.3.2.6 Fluorene

Fluorene (FLR) is a member of the fused polycyclic hydrocarbon family and is considered a diaromatic. Fluorenes are present in gas oils from conventional and synthetic Canadian crudes at levels of from 3 to 5%. Higher levels of fluorenes up to 6 or 7% can be expected in gas oils from thermal upgrading of heavy ends.

The MAT data presented in Table 3.3.2 reveals this model compound to be an extremely poor gasoline precursor. No significant yields of any products were found except for coke.

Upon analyzing the reactor effluent, only the starting material was found. Therefore fluorene did not crack at the severities used.

3.3.2.7 9-Phenylfluorene

Although it has three benzene rings, 9-phenylfluorene (9PF) is considered a diaromatic. The phenyl group is not part of the fused ring system.

The conversion values observed for 9-phenylfluorene were poor. The C_5+ gasoline and C_6+ gasoline were nearly identical because of the lack of C_5 product. Insignificant amounts of fuel gas or of C_3C_4 products were found. The majority of the reactor effluent was found in the LCO range. Coke yields were low.

The reactor effluent analysis was simple to interpret since only benzene and the feed were present. Therefore 9-phenylfluorene is a poor gasoline precursor.

3.3.3 Feedstock Considerations

Of the seven model compounds studied, four were found to be of promise as molecular probes for the purpose of catalytic cracking studies using conventional microactivity test equipment. The information from gross MAT yields was found insufficient for any systematic study of the cracking behaviour of model compounds whereas the level of detailed speciation offered by the GC-MS methodology used herein gave insight into some of the reaction chemistry. In view of the model compounds used and the cracking parameters employed, it would have been impossible to study all but a few of the major catalytic mechanisms, regardless of the degree of reactor effluent speciation. The multiplicity of primary cracked products and the added secondary products produces a situation whereby the primary reaction schemes cannot be readily derived, if at all.

The paraffinic model compound 2,6,10,14-tetramethylpentadecane, the naphthenic materials 1,3,5-triisopropylcyclohexane and 1-octadecene and the aromatic compound 1-phenyldodecane were chosen as suitable candidate feedstocks. All of the above are representative of major hydrobarbon family types found in fluid catalytic cracking feedstocks. All are excellent gasoline precursors and have unique cracking qualities such as high levels of aromatization, hydrogen donation and paraffin production.

3.4 Task 3 Cracking Yields for Major Sulfur and Nitrogen Species

3.4.1 Experimental Design

Fluid catalytic cracking feedstocks, particularly those cut from heavy and synthetic crudes, contain a major amount of high molecular weight sulfur and nitrogen species. Sulfur and nitrogen containing compounds are known to affect catalytic cracking yields. The latter has the greater effect especially when it is basic in character.

A better understanding of the catalytic cracking of heavy and synthetic feedstocks and the role of the cracking catalyst would be gained by studying the cracking patterns of selected members of these sulfur and nitrogen compounds. Six compounds representing thiols, sulfides, aromatic sulfur and aromatic nitrogen were selected as model feeds and appear in Table 3.4.1.

The feeds were cracked in a MAT apparatus using the same operating parameters as described in Section 3.3.1.

3.4.2 Experimental Results

Microactivity test yield structures are presented in Table 3.4.2 for all six feeds studied. Detailed reactor effluent compositional data are also tabulated for the three crackable sulfur feedstocks. The actual raw data can be found in Appendix I.

The cracking patterns for each of the feeds studied are discussed in the following sections. Carbon number distributions are given for the total reactor effluent as well as the paraffins, naphthenics and aromatics.

3.4.2.1 1-Octadecanethiol

Octadecanethiol (C18S) is a straight chained saturate sulfur compound representative of the paraffinic sulfur in gas oil cuts. Sulfur content at 11.8% is about three times that expected in a gas oil cut from a heavy, high sulfur Canadian crude such as Cold Lake.

Conversion values calculated from microactivity yield data showed octadecanethiol to be easier to crack than the corresponding paraffin. The yield of C_5+ gasoline was lower compared to other C_{18} aliphatic feedstock such as octadecane or octadecene but this was in part due to the much higher fuel gas make observed. The C_3C_4 product yields were similar to the corresponding olefin while the same was observed for LCO, DO and coke makes.

The reactor effluent carbon distribution featured the characteristic bimodal profile observed for many of the other model compounds studied. The lack of any significant C_{18}+ compounds supported the earlier observation as to the ease of cracking n-octadecanethiol relative to n-octadecane, cf. Figures 3.4.1 and 3.2.20.

The feed sulfur was not found in the liquid products from cracking octadecanethiol except at trace levels. The majority of the sulfur was recovered as hydrogen sulfide in the light gases as seen from the reactor effluent composition, Table 3.4.2. Sulfur mass balances could only account for approximately 35% of the original sulfur in the feed because of the solubility of H_2S in the gas collection system brine. Acidifying the brine improved the sulfur balance up to 60-65% recoveries. The remaining sulfur losses were attributed to incomplete H_2S recovery and unidentified low molecular weight organosulfur compounds such as methanthiol, ethaniol or propanethiol.

The paraffin distribution of the cracked product resembled those obtained from octadecene or tetramethylpentadecane more than the one for octadecane. The paraffins in general exhibited a low sensitivity to overcracking at the three contact times used as evidenced by the nearly constant yields of C_3, C_4 and C_5 paraffins and C_3 olefins.

The naphthenic distribution was observed to be typical relative to other aliphatic paraffins and octadecene. There were no naphthenic sulfur species detected in the reactor effluent such as thiocyclopentane.

The cracking of octadecanethiol produced over 18% total aromatics of which the majority were identified as alkylbenzenes. Above C_{12}, the substituted naphthalenes predominated and traces of polyaromatics such as the phenanthrenes and pyrenes were also identified. The second mode in the reactor effluent carbon distribution owed much of its existence to the aromatics which were more heavily distributed in the C_8 to C_{11} range.

Relative to other C_{18} compounds, octadecanethiol gave a moderate amount of coke but a significant amount of hydrogen.

The gasoline produced from cracking octadecanethiol as feedstock was found to be nearly sulfur free and highly paraffinic with about 10% aromatics and 8% naphthenics. Hydrogen sulfide accounted for over 65% of the fuel gas stream which, on a H_2S free basis was similar in composition to the fuel gas produced from cracking aliphatic hydrocarbons.

The concentration of both C_4 and C_5 isoparaffins in the reactor effluent decreased with increasing contact time. This was not observed for any of the n-paraffins studied nor was it observed for octadecene, tetramethylpentadecane or 1-phenyldodecane. The presence of sulfur species may have an effect on isomerization reactions. A more detailed systematic study of the C_4 to C_5 paraffins and olefins would be needed to ascertain the magnitude and extent of the effect and also its cause(s).

The high level of hydrogen found in the reactor effluent appears to indicate a poor hydrogen transfer potential for the catalyst. This and the poor isomerization of low molecular weight paraffins may be related.

3.4.2.2 Undecylsulfide

A symetric linear compound, di-n-undecylsulfide is an organosulfur which has the sulfur atom as part of the chain rather than a substituent. With a molecular weight of 342 it is one of the heaviest feeds used. Its sulfur content expressed as mass% is 9.3% which is over twice the amount expected from sour, heavy crude gas oils.

The cracking of undecylsulfide produced a large amount of fuel gas and about 1-2% lower C_3C_4 than expected on a sulfur-free basis. The yields of C_5 material were low but the total C_6+ gasoline yields were average or even slightly above expected. The amounts of LCO and of DO were found two to three times the values expected of paraffinic feeds while the coke make found was 50% higher than the coke from paraffinic feedstocks.

The reactor effluent composition, Table 3.4.2 revealed a few organosulfur compounds in the gasoline range. The compounds were identified as thiophene and thiocyclopentenes.

The reactor effluent carbon distribution, Figure 3.4.2, featured the typical bimodal distribution but with two differences. Firstly the yield of C_{11} compounds was atypical but expected from the symetrical C_{11}-S-C_{11} molecule. Secondly, the cracking of undecylsulfide produced about twice the amounts of methane, ethane and ethene expected compared to other hydrocarbons cracked. The lack of any significant amounts of C_{18}^+ material was indicative of the ease of cracking this feedstock.

The paraffin distribution showed the presence of C_{11} saturate products which decreased in amount as the contact time increased to form more secondary cracked products. Little or no C_9 or C_{10} paraffins were found indicating the loss of C_1 and C_2 fragments were not favoured. Other fragments expected from the secondary cracking of undecane were all present, i.e. C_3-C_8.

The naphthenic profile was very similar to the paraffin profile in the C_6 to C_{11} range. The characteristic high yield of propene and butenes were found with an unexpected 1% of ethene. Total naphthene yields were about 19% of charge.

Alkylbenzenes were found in large quantities in the reactor efffluent with moderate quantities of substituted diaromatics, mostly naphthalenes. Unlike the paraffinic and naphthenic distributions, the aromatic profile stretched beyond C_{11} compounds. Aromatics accounted for 32% of the reactor effluent of which 8%FF were compounds of carbon number greater than eleven.

The distribution patterns for the paraffins, naphthenics and aromatics strongly favoured scission of one of the carbon sulfur bonds. The addition of a sulfur within the hydrocarbon chain has enhanced the propensity for aromatics formation.

The gasoline product would be expected to be high in octane due to the nearly 40% aromatic content. The product would also be unstable because of the high olefinic content.

3.4.2.3 Octylsulfide

Di-n-octylsulfide is a symetric linear organosulfur compound of molecular weight 258. It is of the same family as undecylsulfide. The sulfur content is 12.4%.

The microactivity test data showed octylsulfide to be a better gasoline maker than undecylsulfide. The C_3C_4 yields were also higher as was the fuel gas make. Overall the product structure for octylsulfide was slanted more towards the lighter materials than the yield structure for undecylsulfide which was expected from structural considerations of the original feed in each case.

Fuel gas make was nearly twice that of undecylsulfide, all of which was found attributable to hydrogen sulfide. The yield of H_2S was nearly stoichiometric with only small amounts of thiophenic sulfur detected.

The reactor effluent carbon distribution presented the simple and limited profile expected. The number of cracking steps which either of the octyl groups in the original feed could have gone through would be limited to one. The products expected were therefore C_3, C_4 and C_5 compounds which in fact were the ones found.

The C_8 material was found to be nearly 80% paraffinic. The remainder of the paraffins were grouped around C_4 and C_5 for which i-butane and i-pentane were the major products.

The yield of naphthenic C_8 material was an order of magnitude less than the paraffins. The overall profile was similar to the paraffin distribution.

The aromatics represented about 10% of the total effluent. As with undecylsulfide, the products were distributed above C_8 although the C_8 alkylbenzenes predominated. The C_9 and higher aromatic products were determined to be monoaromatics rather than naphthalenes or indanes. This is consistent with the observed overcracking of the C_9-C_{13} aromatics at higher contact times.

Octylsulfide produced a simple and limited cracked product profile. The preliminary cracking would yield mostly C_8 molecules that would only crack once more to product the secondary and final cracked material, the C_3 to C_5 species. Therefore the reactor effluent would contain C_3, C_4, C_5 and C_8 products which was exactly as found.

The gasoline produced would be over 60% paraffinic and very light. The aromatic and naphthenic compounds would be in nearly equal proportion giving the product a high octane value.

3.4.2.4 Dibenzothiophene

Dibenzothiophene represents the polyaromatic thiophenic sulfur compounds which are found in heavy crudes. The sulfur content is high at 17.4%.

The compound did not crack to any appreciable extent under the conditions of the MAT experiments run. Conversion values of between 4.7 to 6.7 were calculated from the yield data which showed 91 to 95% LCO.

The analysis of the reactor effluent showed the products to be unconverted feed. No further work was done with this material.

3.4.2.5 2,6-Di-t-Butyl-4-Methylpyridine

This model feed is representative of a large group of heterocyclic nitrogen compounds found in crudes. The nitrogen is basic in character and therefore acts as a catalyst poison.

From microactivity test data, Table 3.4.2, the conversion values were calculated at between 7.5 and 10 indicating the compound did not crack or the catalyst was completely deactivated. The gasoline yields were of the order of 1 to 4%.

Analysis of the reactor effluent showed some dealkylation had taken place but the majority of the product was the original feed. No further work was undertaken with this model feed.

3.4.2.6 9-Phenylcarbazole

This model feed is representative of polyaromatic nitrogen which does not have any appreciable basic character, i.e. neutral.

The yield profile showed only small amounts of cracked products which was expected in view of the stability of the starting material. Conversion was from 6 to 12% with 3 to 8% yield in gasoline material.

Analysis of the reactor effluent revealed only the original feed with some carbazole and benzene. The nitrogen-carbon bond of the phenyl had ruptured with little evidence for ring opening of the carbazole moiety. No further work was done with this fuel.

3.4.3 Consideration for Major Sulfur and Nitrogen Feedstocks

Of the four sulfur compounds studied, the thiol and sulfide type feeds were chosen as potential blend components because they represent two different types of sulfur and both are crackable offering the widest interaction for the intermediate sulfur species. Dibenzothiophene does not crack and could be used for very selective studies. Of the two sulfides, octyl sulfide would be the preferred candidate because its product structure would have a minimum impact upon the yield structure of a blend while still providing the effects of the sulfur.

Only 2,6-di-t-butyl-4-methylpyridine showed any promise as a blend component for the study of nitrogen poisoning. Due to its particular steric hindrance around the nitrogen, this compound can differentiate between Lewis and Bronsted acid sites which makes this a valuable molecular probe for selective studies. Presently, it would be preferred to use a non selective organonitrogen compound such as pyridine to study the overall effects which is more in keeping with the objectives of the present program. In addition, the cracking behaviour of the feed could then be studied without having the nitrogen compound overlaying its own cracking pattern on top of it.

3.5 Task 3A Effects of Nitrogen Poisoning on Cracking Yields

3.5.1 Experimental Design

Basic nitrogen in the form of organonitrogen compounds in FCC feedstocks are known to seriously affect the performance of acidic zeolite cracking catalyst. This section deals with the study of the effects upon the cracking yields of model feeds when the latter are spiked with basic nitrogen compounds.

Three blended model feeds were spiked with pyridine in such a way as to obtain nitrogen contents of 400, 800, 1600 and 3200 ppm in the total feed. These spiked feeds were then cracked at a reactor temperature of 480°C and a fixed cat/oil ratio of four. Contact time was constant at 60 seconds. Microactivity yields were obtained in the normal manner.

The reactor effluent liquids were further analyzed by GC-MS to produce detailed and comprehensive yield data for individual hydrocarbon types.

The feed compositions are discussed in detail within Section 3.6. The actual nitrogen content of the feeds were measured and the results are shown in Table 3.5.1.

3.5.2 Microactivity Test Data

Full MAT product yield structures are presented in Table 3.5.2 for the three blends studied. The detailed compositional yields are also shown. For comparative purposes and data integrity, blank runs have been added which represent zero levels of nitrogen.

Analytical MAT yields were calculated from the compositional yield data and appear in Table 3.5.3. Conversion values were then calculated from these yields. The analytical MAT yields are discussed in the following sections.

Conversion values were plotted against feed nitrogen concentration for each feedstock and appear in Figure 3.5.1. At nitrogen levels below 1000 ppm the data was inconclusive showing a maximum for blend A, a downward trend for blend B and a minimum for blend C. But when all of the data was considered up to 3200 ppm nitrogen, the effect of feed nitrogen became evident. The conversion values for blend B decreased sharply with increasing feed nitrogen content. Blend C was not as severely affected initially but rapidly lost conversion at nitrogen levels above 1200 ppm. The conversion levels for blend A were the least affected of all.

Gasoline yields were also plotted against feed nitrogen concentration and appear in Figure 3.5.2. Both blends B and C were severely affected by the presence of nitrogen in the feed. Blend A behaved in an atypical fashion featuring a maximum with an overall increase in the gasoline yields.

The combined LCO + DO yields showed an upwards trend for blends B and C while blend A exhibited a minimum. The order of effect is then: B > C > A, the same as for the gasoline yields.

In Figure 3.5.4 are plotted the coke yields against feed nitrogen content. In each case coke make was reduced with increasing feed nitrogen content at the operating conditions used.

3.5.3 On the Effects of Basic Nitrogen in FCC Feedstocks

The data presented in the preceding section is insufficient for a full quantitative evaluation of the effects of feed nitrogen upon the cracking activity of the catalyst. A knowledge of the behaviour of the product yields with respect to conversion is required for each feed at each nitrogen level in order to ascertain the magnitude of the effects of feed nitrogen. Qualitative discussions are presented based on the MAT data and the compositional yields presented in Tables 3.5.3 and 3.5.2 respectively.

As shown in Figure 3.5.1, the conversion values for blends A, B and C decreased with increasing feed nitrogen content although the magnitude of the effect was very feed dependent. The model feed "Blend A" showed the least amount of sensitivity to the presence of nitrogen. The coke makes for each of these feedstocks did however exhibit about the same sensitivity. Conversion and coke make are good indicators of catalyst activity or the loss thereof, and in all cases they indicate a loss of catalyst activity with increasing nitrogen content in the feed.

The data on product structures given in Table 3.5.3 showed the yields were affected by the presence of nitrogen in the feed. Generally the most important yield to a refiner is that of transportation fuels and gasoline in particular. The gasoline yields plotted in Figure 3.5.2 show a large drop as a function of increasing nitrogen but each curve first shows a slight increase causing a maximum in the profile.

Examination of the compositional yields for blend B revealed the increase in gasoline was due entirely to compounds in the C_9-C_{11} range. Moreover the front end had lost over 5% higher octane materials such as i-pentane and the C_7 to C_9 alkylbenzenes. The net result was a heavy, lower quality gasoline product and less of it.

The reduction in the lighter gasoline components was paralleled by an even greater loss of C_3 and C_4 components, all of which indicate loss of zeolite cracking activity. In addition, the detailed reactor effluent analysis, Appendix I, showed that unreacted feed had increased by 3% on charge while the loss of C_5s and lighter compounds amounted to over 8%FF. The net effect is to increase the average molecular weight of the reactor effluent. Therefore the increase in gasoline yield observed for blend B at low nitrogen concentrations is the result of a reduction in the overcracking of the gasoline product due to a net loss of catalyst activity by nitrogen poisoning.

At higher levels of nitrogen the amounts of unreacted feed components found in the reactor effluent increased sharply. Also the yields of propene and butenes decreased rapidly as do the yields of isomerized products such as i-butane and i-pentane, and the amounts of C_7 to C_{10} alkylbenzenes. All of the above supports the rapid deactivation of the zeolite catalyst by nitrogen poisoning.

The foregoing arguments and conclusions can be applied to blend C as well. The behaviour of blend A is atypical and may in part be due to its high sulfur content which acts as a natural passivator against nitrogen. The net effect upon the component yields as described herein is clearly seen in the reactor effluent carbon distribution profiles for blends A, B and C shown in Figure 3.5.5-3.5.7 respectively.

3.5.4 On the Atypical Behaviour of "Blend A"

Model feed "Blend A" is highly paraffinic being composed of 50% dotriacontane and 25% saturate aliphatic organosulfurs. The remaining 25%, phenyldodecane, is made up of a monosubstituted alkylbenzene in which two thirds of the carbons are paraffinic and the last third are aryl.

It will be remembered from Figure 3.5.2 that the C_5-C_{11} gasoline range material did not show the large loss in yields with increasing feed nitrogen as did blends B or C. In fact, the yields appeared to improve. The overall reactor effluent profile, Figure 3.5.5, confirms this first observation but gives a better appreciation for how this came about and the implications thereof.

The cracked product consistently lost front end material as feed nitrogen increased. The C_6 and C_7 material remained relatively constant in total yields while C_8-C_{10} compounds incresed significantly.

The increase in C_8 products is due entirely to aliphatic paraffins and olefins. These are the major products expected from low severity cracking of octyl sulfide. Alkylbenzene, indanes, olefins and paraffins contributed equally to the increased C_9 products. The aromatics would be from the organosulfur compounds. The increase in C_{10} compounds is due mostly to paraffins and olefins with moderate contributions from both mono and diaromatics. The C_{10} aromatics are major products from the low severity cracking of phenyldodecane.

The level of unsaturate products increased for all carbon numbers except 3 and 4. This is indicative of lower severity cracking with a reduction of hydrogen transfer activity.

In summary then, the increase in the yields of gasoline were due to the substantial rise in the C_8 to C_{10} components, the low severity products expected from octyl sulfide, octadecanethiol and phenyldodecane. The overall paraffin content increased as did the level of unsaturates. All but the C_{10} alkylbenzenes were reduced as feed nitrogen increased. Overall the gasoline became heavier, and of lower quality due to the loss of high octane paraffins and gum forming olefins. In retrospect, the behaviour of blend A is similar to that of blends B and C.

3.6 Task 4 Key Component Blends and Synergistic Cracking Effects

3.6.1 Key Component Blends

Three blends of model compounds were selected as the experimental feeds. The components for each were selected from the group of pure compounds studied in the earlier tasks, Sections 3.2, 3.3 and 3.4. Component selection was done on the basis of formulating three feeds with wide varying characteristics representative of different FCC feedstock types. The compositions of the blends are given in Table 3.6.1.

Blend A was formulated as a light paraffinic feedstock such as BC Light but with 2.94% sulfur. Blend B was composed as a more conventional feedstock with a distributed saturate, naphthenic and aromatic makeup such as that of an IPL crude. Blend C was made up to be mainly aromatic, naphthenic and olefinic to represent synthetic feedstocks.

3.6.2 Microactivity Test Results

Each blend was cracked in a MAT unit at a reactor temperature of 475-480°C and a cat/oil ratio of four using equilibrium DA-440 catalyst, XC013DE. Product yield structures were established for each blend at contact times of 60, 120 and 200 seconds. Full reactor effluent compositional yields were determined for each run and are reported with the MAT yields in Table 3.6.2.

The carbon distribution profiles were plotted for blends A, B and C and appear in Figures 3.6.1, 3.6.2 and 3.6.3 respectively. The reactor effluent carbon distribution for each blend features a relatively smooth, bimodal profile.

3.6.3 Theoretical Product Yield Structures

It will be remembered that pure compounds used in preparing the blends were cracked neat and reactor effluent compositions determined, Sections 3.2, 3.3 and 3.4. Knowing the composition of the blends it was then possible to calculate a theoretical reactor effluent composition for cracking the blend based on the sum of the individual reactor effluent components of the pure compounds. For a given blend X, the theoretical concentration of the ith component would be:

$$C_i = f_1 C_{(1,i)} + f_2 C_{(2,i)} + \dots + f_n C_{(n,i)}$$

where C_i - is the theoretical yield of the ith component in the reactor effluent from cracking feedstock X.

$C_{(n,i)}$ - is the concentration of the ith component as measured in the reactor effluent of blend compound n.

f_n - is the fraction of compound n in the blended feedstock X.

Using the theoretical reactor effluent compositions, Table 3.6.3, it was then possible to calculate theoretical MAT yields. The end point of the gasoline range was selected as C_{11} inclusive which defines the LCO and DO as C_{12}+ material. Conversion values were then calculated from the MAT yields in the normal fashion. The theoretical yields are given in Table 3.6.4.

Analytical MAT yields, calculated from the observed reactor effluent compositions, are also given in Table 3.6.4 for comparative purposes.

3.6.4 Synergistic Effects

Comparing the theoretical MAT yields with the experimentally measured values revealed significant differences. The lighter products including gasoline were over predicted while the heavier liquids and the coke yields were under estimated. Both blends A and C showed a significant drop in actual versus theoretical conversion where blend B had a smaller difference, but directionally the same.

The differences between the experimental and theoretical yields was found to be due to a greater propensity for aromatics production in a blended feedstock relative to any of the blend components, cf. Tables 3.6.2 and 3.6.3. Moreover, the aromatics in question were condensed multiring structures, the naphthalenes, phenanthrenes and pyrenes, cf. Appendix I.

The logical extension of this behaviour would be to produce more condensed polyaromatic structures and hence more coke which, in fact, was observed. Also, a large amount of condensed polyaromatics produced from a paraffinic starting material such as blend A would have to dehydrogenate significantly and therefore liberate an appreciable quantity of hydrogen, which in fact was the case.

3.7 Task 5 The Effects of Residual Catalyst Coke on Cracking Yields

3.7.1 Deactivation by Coke

During the cracking reaction of hydrocarbon feedstocks on acid catalysts there is a net production of highly carbonaceous coke. Coke residues generally have hydrogen/carbon ratios of from 0.3 to 1.0 and exhibit features not unlike those of high molecular weight, condensed polyaromatics. Coke deposit adversely affects cracking catalyst activity by blocking pores and inhibiting access to active cracking sites. The origin of coke, its structure and its effects on activity have been extensively studied (31-34).

The effects of residual coke at levels below 0.5 mass% were studied herein by cracking the three model feeds over catalyst containing known levels of coke. The catalyst samples were prepared as described in Section 2.3 and contained 0.11, 0.27 and 0.48 mass% residual coke. The feeds were cracked in the MAT unit at a temperature of 475-480°C and a fixed cat/oil ratio of four at contact times of 60, 120 and 200 seconds. Full MAT yield structures were determined in the usual manner while compositional analysis by GC-MS was used to produce the reactor effluent compositional yields.

3.7.2 Microactivity Test Run Results

Twenty-seven microactivity test runs were performed in order to obtain the data summarized in Table 3.7.1. Product yield structures and reactor effluent compositional analyses are given for each cracking experiment. Detailed compositional analyses of the reactor effluent liquids are tabulated in Appendix I.

3.7.3 The Effects of Residual Coke

Residual coke on cracking catalysts did affect the yield structures obtained from cracking the three model feeds as seen from the MAT yields given in Table 3.7.1. The extent of the effect upon transportation fuel products appears to be feed dependent and related to the amount of overcracking taking place.

In order to better appreciate the effect of residual coke on cracking yields, the conversion values for blend A were plotted as a function of coke on regenerated catalyst, Figure 3.7.1. Base case data is shown which was obtained by running the fully regenerated catalyst, zero coke. At all three contact times increased coke on regenerated catalyst led to a decrease in the observed conversion values. The effect could be interpreted in various ways: 1) coke on catalyst acts as a fouling agent, blocking access to active sites and therefore reduces the activity of the catalyst, 2) residual coke leads to secondary reactions which alter the product structures, or 3) a combination of fouling and of secondary reaction fostering.

If the effects were only due to fouling and hence a loss of catalyst activity, loss of conversion would be almost feed independent. Secondly, the product structrure would be affected by shifts in the overall average molecular weight and small variations in compositions but mostly the effects would be expected to be seen as a rise in unconverted feed and the high molecular weight primary products of cracking. In Figures 3.7.2 and 3.7.3 conversion was plotted as a function of coke on catalyst for the remaining two blends B and C. The effects of residual coke appear to be not only feed dependent but also contact time dependent, which indicates that simple fouling was not totally responsible. At low contact times, the effect of residual coke on conversion was found to be nearly independent of feed composition as seen in Figure 3.7.4.

A study of the detailed reactor effluent compositions, Appendix I, showed the levels of unreacted feed in the cracked product to vary only slightly with increasing coke on catalyst, of the order of 1% FF or less, and therefore a very minor cause of any loss of conversion observed. The principal effect upon cracking yields was found at the component level as the data in Table 3.7.1 clearly shows. The amounts of aromatic products increase sharply as a function of residual coke. The compounds responsible for the increase were identified as di-, tri- and tetraaromatice rather than alkylbenzenes. The detailed reactor effluent analyses, Appendix I, show increases in substituted naphthalenes, indanes, phenanthrenes, fluorenes and pyrenes as coke on regenerated catalyst increases.

The yields of gasoline material were also adversely affected by coke on the cracking catalyst as shown by the yields of C_5+ gasoline plotted in Figures 3.7.5, 3.7.6 and 3.7.7 for blends A, B and C respectively. But, the quality of the product appeared to improve due to the decreased paraffinicity and increased aromaticity.

Therefore, it was found that coke deposits on cracking catalyst enhanced the production of aromatic material in the gasoline, the LCO and the DO. In the latter two products these aromatics were further identified as being preferentially polyaromatics with low hydrogen to carbon ratios. Coke on catalyst was also found to increase the yields of coke, a phenomena which would be an extension of the already identified propensity towards the formation of polyaromatics in the LCO and DO.

The data herein is insufficient to identify or elucidate the mechanisms of or the catalytic sites responsible for the formation of the multiringed aromatics found in such large quantities in the reactor effluent.

3.8 Task 6 Hydrothermal Deactivation of Cracking Catalyst

3.8.1 Hydrothermal Stability

It would be impossible to operate commercial FCC units using freshly prepared catalyst because of its inherent high activity and the high rate of activity loss or deactivation which occurs initially. In a commercial reactor the catalyst will find itself in the presence of hydrocarbons of varying molecular weight and composition including components containing sulfur, nitrogen, and heavy metals. These latter species, found in increasing concentration in heavier and synthetic feedstocks, are undesirable because of their adverse effect upon atmospheric emissions, product quality, and also the deactivation of the catalyst. Temperatures at the bottom of a riser reactor will typically be between 500 and 600°C when cracking gas oil feeds but higher temperatures up to 650°C can be necessary to properly crack heavier resid feedstocks. During the cracking process, coke is deposited on the catalyst surface and the processing of heavy feeds generally leads to much larger quantities of carbonaceous material on the catalyst. Before entering the regenerator, the catalyst is steam stripped at about reactor exit temperature (520°C) in order to remove volatile hydrocarbons from inner pores. In the regenerator, the carbonaceous deposit is burned off in a controlled manner at temperatures of 700 to 730°C. The regenerated catalyst is returned to the reactor and used again in the cracking process. Thus each cycle involves exposure to hydrocarbons, heavy metals, steam, air and to high temperatures. All these have an effect on both the physical and chemical properties of the catalyst in the reactor.

Processing heavier feeds and synthetic feedstocks creates additional stresses on the catalyst because of the higher levels of sulfur, nitrogen and heavy metals but also because of the higher regenerator temperatures engendered by the larger amounts of coke which must be burned off. Resid cracking also requires higher catalyst-feed contact temperatures at the bottom of the reactor which causes severe thermal shock to the catalyst. It is therefore important that the catalyst be hydrothermally stable.

Hydrothermal deactivation of fresh catalyst is rapid and results in a pseudo-equilibrium material. The longer term stability of DA-440 was studied in this work at elevated temperatures with and without the presence of water. Samples were thermally and hydrothermally deactivated for known periods of time at set temperatures as given in Table 3.8.1. Catalyst preparation is covered in detail in Section 2.3 and the physical and chemical analyses are discussed in Section 3.10.

The three model feeds were cracked in a MAT unit using each of the prepared catalysts and full product structures were determined including detailed compositional analysis of the reactor effluent. The results of this work are presented here.

3.8.2 Microactivity Test Results

Fifty-four MAT runs were performed in order to study the behaviour of the six catalyst samples towards long term hydrothermal stability. The three model feeds were cracked at contact times of 60, 120 and 200 seconds over each of the test catalysts. The results of the work are summarized in Table 3.8.2 and the detailed reactor effluent liquid compositional analysis is given in Appendix I.

The activity of the steamed and thermally deactivated samples were relatively higher than the activity of the equilibrium DA-440, cf. Table 3.6.2, as evidenced by the higher yields of light products, C_3C_4 and C_5; the overcracking of the gasoline ranged material; the lower yields and more refractive nature of the LCO and DO; and the much higher coke makes. Thermal deactivation affected the catalyst properties to a lesser extent than did steaming even though the thermal treatment was done at a much higher temperature than the steaming. Comparing the 8 and 16 hours steamed catalyst with the similar thermally shocked catalyst shows the latter to be more active.

The catalyst was found to be stable with respect to long term hydrothermal deactivation. The overall yields were not affected to any appreciable extent nor were the compositions of the reactor effluent at the molecular yield level.

3.8.3 Extreme Thermal Deactivation

There are limits of thermal and hydrothermal conditions above which the catalyst will no longer be stable and massive deterioration of the zeolite framework will occur. As an example, a sample of fresh DA-440 was thermally deactivated at 899°C for 16 hours. Analysis of the catalyst after treatment revealed that it no longer had a measurable % crystallinity or unit cell size indicating that the zeolite structure had been destroyed.

Using the deactivated catalyst, model blend B was cracked in the normal way and yields obtained. The data appear in Table 3.8.3. Reactor effluent compositions were not determined as this work falls outside the scope of this program. When compared to the yields obtained with thermal deactivation at 860°C, Table 3.8.2, it was found that the catalyst was indeed severely deactivated. The yields of light product were halved while the yields of LCO were four to five times greater. Coke make, a good indicator of cracking activity, was more than an order of magnitude lower. Conversion values reflected the high yields of LCO and were found to be in the range of 56 to 65 compared to the 90+ observed for deactivation at 860°C.

3.9 Task 7 The Effects of Metals Impregnation on Catalyst Cracking

3.9.1 Metals Deactivation

The processing of heavier crudes in Canadian refineries would impose additional constraints on the catalytic cracking units and on the catalyst in particular due to the higher metals loading. Light and medium Western Canadian crudes such as Federated, Rainbow and Rangeland-South have concentrations of heavy metals, nickel and vanadium, in the range of 0.01 to 10 ppm based on the crude. Heavier Canadian crudes such as Bow River Heavy, Lloydminster and Wainwright-Kinsella have nickel and vanadium contents which range between 40 and 200 ppm. And since the metals, as porphyrins complexes, are concentrated in the heavier fractions during crude distillation, the levels of metals in FCC feedstock can be very high, especially if resid cracking is being practiced.

The effects of metals on the performance of zeolite cracking catalysts have been reported by Mitchel (35), Jaras (36), Andersson et al. (37), Pompe et al. (16), Masuda et al. (38), Occelli et al. (39) and Wormsbecher et al. (40). It is the objective in this study to examine the effects of nickel, vanadium and nickel + vanadium on the performance of fresh, steam deactivated DA-440 catalyst at levels of metals poisoning typically encountered in operating fluid catalytic cracking units. The method used to prepare the catalyst samples is discussed in Section 2.3.

3.9.2 Cracking Yields for Metals Impregnated Catalysts

The nine catalysts were prepared with nickel, vanadium and nickel + vanadium levels of the order of 500, 1000 and 2000 ppm of each metal. The analytically measured metals concentration are given in Table 3.9.1. The three model feeds were cracked using the metal impregnated catalysts at contact times of 60, 100 and 200 seconds to produce 81 experimental runs which are summarized in Table 3.9.2. An additional series of 33 runs were performed using an IPL gas oil and Blend B as feeds.

3.9.3 The Effects of Nickel Poisoning

The presence of nickel on the cracking catalyst affected the yields in a number of ways but none so severely as the hydrogen yields. Using the average hydrogen yields obtained with steam deactivated catalyst with no metals, Section 3.8, the contaminant hydrogen values were calculated as:

$$H_C = \frac{(H_M - H_Z) * 100}{H_Z}$$

where H_C = contaminant hydrogen as a % basecase
H_M = observed hydrogen yields, metal contaminant
H_Z = observed hydrogen yield, zero metals.

The contaminant hydrogen values were calculated for blend A at all three contact times and at the different nickel levels. The data were plotted against nickel concentration and are shown in Figure 3.9.1. Contaminant hydrogen increases rapidly as a function of nickel on catalyst and appears to be independent of contact time although with such limited data it is not possible to ascertain.

Nickel on the cracking catalyst was also seen to cause increased coke yields. Contaminant coke, calculated in a manner similar to hydrogen, were plotted in Figure 3.9.2 as a function of nickel on catalyst. Coke appears to increase rapidly at first with Ni up to levels of about 1000 ppm Ni, but then as the Ni increases, the amount of additional coke produced is limited.

It was also noted that nickel shifted the yields towards olefinic products away from paraffins, especially in the light gases as exemplified by the propene to propane ratio plotted in Figure 3.9.3. The magnitude of the effect may also be contact time dependent as shown in the plot but more data is required for confirmation.

All of the above observations, plus the increases in LCO and DO yields noted with increased nickel on the catalyst, are indicative of degraded product selectivities and reduced activity caused by the nickel on the catalyst. Similar arguments can be made for the other two feeds studied.

3.9.4 The Effects of Vanadium Poisoning

Vanadium was not found to promote dehydrogenation but did affect the yields as evidenced by the increasing amounts of LCO and DO produced as vanadium content went up. Overall, this catalyst was found to be very tolerant of vanadium poisoning.

3.9.5 The Effects of Nickel and Vanadium

Catalyst impregnated with both nickel and vanadium showed mostly the trends established for nickel. Activity losses were slightly higher for the nickel and vanadium than for either metal alone as shown by the amounts of LCO and DO produced. But, because of the serious overcracking and the limited amount of data available, finer trends and effects are not identifiable.

3.9.6 On the Cracking of Gas Oils

An IPL vacuum gas oil was cracked over the nickel and vanadium impregnated catalysts and found to give a much clearer definition to the metals effect than was observed with the model feeds. The data are presented in Table 3.9.3.

Conversion data was plotted in Figure 3.9.4 where the reduction in cracking activity due to metals is clearly shown. The curves were found to be in the order expected with respect to cracking severity and did not indicate a strong dependence of metals deactivation relative to contact time. Metals poisoning affected the activity of the catalyst regardless of cracking severity.

Gasoline yields are of prime importance and here again the presence of metals on the catalyst proved to have adverse effects as seen from the data plotted in Figure 3.9.5. At low metals loadings the curves featured a small maximum which quickly degraded at metals concentrations above 1500 ppm. This apparent increase in gasoline yields was found to be an artifact of the reduced cracking activity countering an overcracking of the gasoline. The degradation and loss of catalyst activity due to the metals was undeniable in view of the accumulated evidence; viz, loss of conversion (Figure 3.9.4), increased LCO yields, (Figure 3.9.6) and the decreased yields of C_3C_4 (Figure 3.9.7).

The effect upon coke yields was found to be complex due to the competing factors involved. The metals on the catalyst tended to reduce the cracking activity and hence decrease the coke make. But, nickel and vanadium (Figure 3.9.8) both show a tendency to increase the amount of coke produced. Therefore a comprehensive description of the effects of metals on coke yields would require a systematic and detailed study of the behaviour of coke yields as a function of conversion at each level of contaminant metals. The information herein is insufficient for this purpose but, generally, metal loadings above 2000 ppm resulted in large amounts of coke being produced.

3.10 Task 8 Determination of Catalyst Properties

3.10.1 Physical and Chemical Properties

The ideal catalyst is a material that accelerates a chemical reaction without itself being consumed or changed in any way. However, it is a fact of life that catalysts deactivate over time and, for cracking catalyst, deactivation takes place within seconds. Therefore fluid catalytic cracking catalysts must be stripped and regenerated before reuse in a cyclical pattern of reaction-regeneration which, with time, imparts certain irreversible chemical and physical changes to the catalyst.

The most important parameters for cracking catalysts which relate to its performance were measured for all samples of catalyst used for the present work. Pore volume and surface area relate to the permeability of the catalyst particle while percent crystallinity and unit cell size are characteristic of the zeolite only. The chemical properties, except for alumina, are indicating of the amount of poisoning and deactivation the catalyst has experienced. Carbon in particular is a measure of regenerator efficiency.

3.10.2 Analytical results

The catalyst used in this work was DA-440 fluid catalytic cracking catalyst from W.R. Grace & Co., Davison Chemical Division. A number of physical and chemical parameters were determined for the catalyst used during this work. The results appear in Table 3.10.1 along with additional data for a few related samples.

The percent crystallinity, the unit cell size and the level of rare earths identify this particular catalyst as a rare earth exchanged zeolitic cracking catalyst, (REY). The equilibrium unit cell size being of the order of 24.425A further characterizes this catalyst as being a conventional REY catalyst as opposed to a fully exchanged CREY although the level of Re_2O_3 and the percent crystallinity would tend to indicate the contrary.

The analysis of the fresh DA-440, sample XC014DF, gives some base case values from which the equilibration and poisoning of the equilibrium sample XC013DE can be appreciated. The deterioration of the zeolite can be seen from the percent crystallinity loss while the equilibration of the remaining zeolite is evidenced by the unit cell size approaching the value of 24.420A expected for a REY. Metals poisoning is also quite evident as the vanadium and nickel content of the catalyst increase ten fold or more. Copper, which like nickel acts as a dehydrogenation catalyst, also increases sharply. Sodium at the 0.1 to 0.2% level is present in fresh catalyst due to the limits of exchangeability and it is also found in the clay and binders used in the matrix portion of the catalyst. During use the catalyst will become contaminated with additional sodium which can cause problems because of its deleterious effects on the zeolite structure.

Hydrothermal and thermal treatment of the fresh catalyst led to some permanent changes in the physical as well as chemical properties of the catalyst. Hydrothermal deactivation resulted in a sharp drop in the zeolite content (percent crystallinity), dealumination (unit cell size), and loss of some of the sodium. Surface area and pore volume were also reduced while the average particle size remained fairly constant. Thermal deactivation did not affect the zeolite as extensively (percent crystallinity and unit cell size) but appears to have done permanent damage to the binder since the average particle size (attrition) was halved and surface area increased relative to the hydrothermal material. This catalyst cooking at 860°C also produced chemical changes since alumina content rose and rare earth levels fell.

Of importance to this work are the special analytical results shown for carbon (Task 5) and nickel and vanadium levels (Task 7). These were especially prepared catalysts for which the carbon or metals were purposely added in order to study the deactivation effects of these poisons.

4. CONCLUSIONS

Fluid catalytic cracking catalyst specifically aimed at processing residua from heavy and synthetic crude feedstocks should be hydrothermally stable, nitrogen resistant, coke selective and metals tolerant in order to perform effectively and be economically attractive to use. The present work has examined experimentally all of these key areas using a single, commercially available fluid catalytic cracking catalyst. A number of observations were made on results obtained during the course of this work and are presented throughout Section 3. The more salient findings are presented here in point form:

- The extent of synergistic cracking effects noted with all three feedstocks studied would indicate that prediction of cracking yields based on feed composition alone would be complex but still feasible. Coke make and the yields of heavier aromatics were found to deviate the most from predicted values.

- Nitrogen poisoning of the cracking catalyst by basic organonitrogen feed components was by far the most severe form of catalyst deactivation examined herein. In view of the high nitrogen content of synthetic crudes, nitrogen resistance in a cracking catalyst or passivation of the nitrogen species within the feed would be fundamental requirements for FCC upgrading of such feedstocks.

- Zeolite, matrix and binder technology, as evidenced by the performance of DA-440, is currently available to produce fluid catalytic cracking catalyst of superior thermal and hydrothermal stability. This eases but does not eliminate a major constraint on regenerator operation required to handle the higher levels of coke anticipated from cracking heavy and synthetic feedstocks.

- Feed sulfur does not appear to affect cracking catalyst activity but, depending on the type of sulfur, does influence product yields and quality, especially coke make and aromatics.

- Cracking catalyst poisoning by metals was not found to be significant below about 1000 ppm on catalyst and the effects of nickel were more pronounced than for vanadium. Nickel acted as a dehydrogenation catalyst while vanadium did not. This has serious implication for cracking heavier materials since any increase in dehydrogenation activity will lead to greater coke yields.

- Coke on regenerated catalyst at levels of 0.3% and greater were found to adversely affect both catalyst activity and gasoline yields. Because of thermal limits upon regenerator operation imposed by the metallurgy of the system and the hydrothermal limits of the catalyst, there exists a maximum allowable coke burning rate in any given regenerator. Therefore any species, such as nickel on the catalyst or olefins and sulfur compounds in the feed, which tend to increase the yields of coke should be minimized.

- The use of high molecular weight compounds as molecular probes in the study of catalytic cracking offers advantages as well as disadvantages. They are representative of gas oil materials and, because of their size, undergo certain key reactions which would otherwise not occur if lighter compounds were used. But the higher molecular weight feeds give very complex yield structures which necessitate large amounts of analytical and data analysis effort in order to sort out properly. Secondary reactions involving the heavier intermediate cracked products lead to complex schemes which make kinetic work unnecessarily long and involved if at all possible. Therefore, considering the ultimate goals, molecular probles should be chosen carefully so as not to overly complicate the analytical and numerical work.

- Relative to typical gas oils, pure compounds and, to a lesser extent, blends of pure compounds are readily cracked in a MAT unit at the conditions generally used for gas oils. This situation leads to overcracking and therefore unrealistic molecular yields in some cases. For this and other reasons, optimum C_6+ gasoline yields should be used to ascertain both contact time and reactor temperature when cracking pure compounds.

5. RECOMMENDATIONS

- The findings presented herein are based on experimental work with a single commercially available REY type fluid catalytic cracking catalyst. This work should be further extended to other commercial catalysts such as the high zeolite content material and ultrastable Y (USY) type faujasites. In addition to the zeolite, attention should be focussed on matrix type and inherent activity for, in the processing of residua, matrix activity is responsible for the initial cracking of the very heavy molecules which then "feeds" the zeolite to ultimately yield the gasoline and distillate range products.

- Catalyst deactivation by nitrogen poisoning is of particular interest in view of heavy oil and synthetic crude upgrading by fluid catalytic cracking because of the inherently high levels of nitrogen compounds found in these feedstocks. Further investigations into the mechanisms of deactivation, especially with USY containing materials or highly dealuminated zeolites, would help gain valuable information on the effects of acid site population, strength and proximity towards nitrogen resistance. The use of special molecular probes such as 2,6-di-t-butyl-4-methylpyridine can be used to differentiate and hence study the differences between Lewis and Bronsted acid sites. Such studies would have the ultimate goal of developing a superior nitrogen resistant catalyst.

- Feed pretreatment is an area of promise where deleterious impurities such as nickel, vanadium, nitrogen and sulfur could be removed, passivated or minimized. Such processes, if successful, would make upgrading of Western Canadian heavy oils and synthetic crudes by fluid catalytic cracking economical thus accelerating the development of these vast resources.

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TABLES

Table 3.2.1
Paraffinic Feedstocks
Physical Constants

		n-Octadecane n-C18	n-Hexacosane n-C26	n-Dotriacontane n-C32
Molecular Weight	g/m	254.5	366.7	450.9
Melting Point	C	28.2	56.4	69.7
Boiling Point	C	316.1	412.2	467.0
Density	kg/dm3	0.7768	0.7783	0.8124
Refractive Index	nD	1.4390	1.4357	1.4550
Hydrogen/Carbon	Ratio	2.11	2.08	2.06

Table 3.2.2
Cracking Yields for Normal Paraffins
n-Octadecane

Contact Time	(s)	60			100			200		
Reactor Temperature	(C)	450	475	500	450	475	500	450	475	500
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	0.31	0.56	1.18	0.32	0.73	1.33	1.18	1.98	2.43
C3C4	:	15.67	27.42	34.13	22.39	31.27	37.71	33.88	37.59	43.67
C5'S	:	5.44	10.63	13.42	9.30	11.86	13.64	13.94	14.56	16.39
C5 + Gasoline	:	38.63	46.46	44.63	51.61	57.62	54.20	57.38	54.05	48.07
C6 + Gasoline	:	33.19	35.83	31.21	42.31	45.77	40.56	43.44	39.49	31.68
Light Cycle Oil	:	43.67	23.69	17.67	23.83	7.83	4.13	4.11	2.47	1.91
Decant Oil	:	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.71	0.48
Coke	:	1.72	1.86	2.39	1.85	2.55	2.63	2.80	3.20	3.44
Conversion	:	56.33	76.31	82.33	76.17	92.17	95.87	95.23	96.82	97.61
COMPOSITIONAL YIELDS - mass %FF										
COMPONENTS										
Hydrogen	:	0.01	0.02	0.07	0.01	0.04	0.06	0.02	0.04	0.08
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.49	0.22
Carbon Dioxide	:	0.06	0.12	0.12	0.09	0.07	0.17	0.38	0.43	0.40
Methane	:	0.14	0.26	0.52	0.15	0.32	0.52	0.31	0.58	0.84
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.06	0.11	0.28	0.05	0.17	0.37	0.17	0.34	0.59
Ethane	:	0.09	0.18	0.32	0.11	0.19	0.37	0.36	0.52	0.68
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	3.82	6.86	8.42	5.19	7.52	9.98	7.88	9.35	11.24
Propane	:	1.34	1.85	2.78	1.42	2.20	2.61	2.38	2.80	3.81
1,3-Butadiene	:	0.00	0.01	0.00	0.00	0.00	0.02	0.05	0.05	0.05
Butenes	:	3.20	7.16	8.40	5.53	7.90	9.87	6.69	7.32	9.00
Butanes	:	9.11	11.86	14.55	10.19	13.58	15.11	16.91	17.99	19.33
C5 Cyclos+Olefins	:	3.23	4.08	4.88	2.91	3.86	4.21	2.49	2.37	2.84
Pentanes	:	6.80	9.47	12.34	10.38	12.22	12.05	13.97	14.42	14.97
Benzene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.14	0.11
C6 Cyclos+Olefins	:	2.22	2.42	2.75	2.05	1.69	2.57	1.68	1.64	1.51
Hexanes	:	6.14	9.21	6.91	9.20	10.97	9.12	6.57	7.00	5.41
Toluene	:	0.25	0.27	0.50	0.29	0.50	0.61	0.47	1.41	0.67
C7 Cyclos+Olefins	:	2.67	3.09	2.22	2.66	2.77	2.40	0.89	1.01	0.51
Heptanes	:	4.65	6.01	4.93	7.59	8.14	7.17	5.35	5.60	3.81
C8 alkylBenzenes	:	1.50	1.68	2.87	1.80	3.05	2.84	2.02	2.54	2.38
C8 Cyclos+Olefins	:	1.59	1.95	1.97	0.43	0.72	0.31	0.66	0.93	0.32
Octenes	:	4.01	4.03	2.82	5.61	5.21	4.89	3.52	4.00	2.19
C9 alkylBenzenes	:	3.08	3.69	3.28	4.17	4.71	4.45	3.24	3.96	3.27
C9 Cyclos+Olefins	:	0.75	0.54	0.30	0.00	0.00	0.00	0.14	0.00	0.00
Nonenes	:	2.42	2.28	1.71	4.03	2.60	2.57	2.91	2.95	2.06
C10 Aromatics	:	1.50	1.88	2.07	3.02	2.49	2.27	2.30	3.03	2.47
C10 Cyclos+Olefins	:	0.42	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	:	1.09	1.48	1.11	1.22	0.00	0.00	2.68	1.41	1.11
C11 Aromatics	:	1.67	0.94	1.11	1.58	0.72	0.65	1.50	0.97	1.84
C11 Cyclos+Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
C11 Paraffins	:	0.42	0.40	0.35	0.00	0.00	0.00	2.07	0.24	0.51
C12 Aromatics	:	0.92	0.34	0.25	0.00	0.00	0.00	1.74	0.85	0.95
C12 Paraffins	:	0.17	0.34	0.20	0.36	0.28	0.28	1.31	0.52	0.51
C13 Aromatics	:	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.40	0.82
C13 Paraffins	:	0.00	0.00	0.00	0.22	0.11	0.17	0.89	0.12	0.06
C14+	:	34.93	15.57	9.78	17.85	5.80	1.74	3.66	1.37	2.00

Table 3.2.3
Cracking Yields for Normal Paraffins
Hexacosane

Contact Time (s)	60			100			200		
Reactor Temperature (C)	450	475	500	450	475	500	450	475	500
MICROACTIVITY TEST-Yield Stuctures mass %FF									
PRODUCTS									
H2 - C2	0.30	0.53	0.86	0.35	0.75	0.52	0.74	1.28	2.13
C3C4	15.51	20.50	27.43	21.22	29.13	31.56	24.20	29.72	38.40
C5'S	8.00	8.63	11.95	8.39	10.14	13.56	10.86	11.43	17.05
C5 + Gasoline	52.88	56.99	53.52	66.69	59.05	58.10	68.10	62.79	53.88
C6 + Gasoline	44.88	48.36	41.56	58.30	48.92	44.54	57.23	51.36	36.83
Light Cycle Oil	7.16	6.98	6.15	7.31	6.31	5.95	3.85	2.63	1.93
Decant Oil	22.43	12.83	9.88	2.24	1.60	0.67	0.06	0.00	0.10
Coke	1.69	2.16	2.17	2.19	3.16	3.19	3.05	3.59	3.56
Conversion	70.41	80.19	83.97	90.45	92.09	93.38	96.09	97.37	97.97
COMPOSITIONAL YIELDS - mass %FF									
COMPONENTS									
Hydrogen	0.01	0.02	0.03	0.01	0.04	0.03	0.03	0.05	0.09
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.06	0.09	0.07	0.06	0.03	0.06	0.17	0.22	0.26
C1 Paraffins	0.12	0.24	0.35	0.14	0.33	0.22	0.22	0.41	0.75
C2 Paraffins	0.12	0.14	0.28	0.14	0.20	0.19	0.28	0.41	0.65
C2 cyclos+Olefins	0.08	0.13	0.20	0.05	0.19	0.07	0.20	0.40	0.63
C3 Paraffins	0.95	1.55	1.70	1.17	2.02	1.84	1.10	1.61	2.52
C4 Paraffins	6.60	8.79	10.08	9.09	12.34	13.89	10.82	12.69	16.02
C3 cyclos+Olefins	3.80	4.85	7.47	5.21	7.04	7.46	6.22	7.93	10.38
C4 cyclos+Olefins	4.14	5.25	8.14	5.70	7.72	8.33	5.94	7.34	9.32
C5-C11 Paraffins	30.24	34.82	27.59	42.60	41.90	37.77	46.56	39.31	35.30
C5-C11 cyclos+Olefins	11.96	10.77	9.04	11.95	8.71	6.97	7.41	6.63	7.30
C6-C11 Aromatics	4.77	7.25	5.50	9.05	8.57	8.63	11.41	12.53	11.38
C12-C19 Paraffins	6.94	3.86	6.71	5.32	2.60	3.74	2.44	1.80	0.52
C12-C19 cyclos+Olefins	1.95	0.86	1.65	0.93	0.11	0.00	0.12	0.15	0.00
C12-C19 Aromatics	2.02	1.93	4.18	4.39	2.32	1.92	3.84	4.72	2.20
C20 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C20 cyclos+Olefins	4.76	1.86	1.87	0.47	1.90	4.59	0.03	0.03	0.01
C20 Aromatics	0.30	0.14	0.33	0.19	0.29	0.63	0.14	0.18	0.10
C21+	19.51	15.29	12.65	1.33	0.55	0.77	0.00	0.00	0.00

Table 3.2.4
Cracking Yields for Normal Paraffins
Dotriacontane

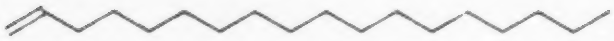
Contact Time	(s)	60			100			200		
Reactor Temperature	(C)	450	475	500	450	475	500	450	475	500
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	0.45	1.09	1.37	0.32	0.81	1.14	0.55	1.11	2.05
C3C4	:	18.17	25.91	27.72	25.37	26.94	32.94	22.35	30.41	36.03
C5'S	:	7.78	10.13	11.89	11.03	11.43	12.67	11.10	11.02	13.88
C5 + Gasoline	:	66.78	62.74	59.99	63.62	60.92	56.90	68.63	60.75	54.12
C6 + Gasoline	:	59.00	52.61	48.10	52.59	49.49	44.23	57.52	49.73	40.24
Light Cycle Oil	:	9.69	5.90	6.12	7.45	6.27	4.50	4.61	3.86	3.30
Decant Oil	:	2.65	1.20	2.15	0.81	1.78	1.28	0.47	0.36	0.29
Coke	:	2.27	3.16	2.65	2.43	3.28	3.24	3.39	3.50	4.22
Conversion	:	87.66	92.90	91.73	91.74	91.95	94.22	94.92	95.78	96.41
COMPOSITIONAL YIELDS - mass %FF										
COMPONENTS										
Hydrogen	:	0.01	0.04	0.04	0.03	0.03	0.06	0.03	0.06	0.10
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	:	0.00	0.00	0.00	0.00	0.05	0.00	0.04	0.00	0.00
Carbon Dioxide	:	0.10	0.15	0.14	0.12	0.16	0.08	1.59	0.17	0.22
C1 Paraffins	:	0.13	0.33	0.44	0.22	0.36	0.55	0.19	0.51	0.87
C2 Paraffins	:	0.18	0.33	0.44	0.07	0.37	0.43	0.27	0.45	0.72
C2 cyclos+Olefins	:	0.12	0.32	0.44	0.00	0.00	0.10	0.00	0.09	0.34
C3 Paraffins	:	0.88	1.53	1.60	1.04	1.29	1.83	0.52	1.53	2.25
C4 Paraffins	:	7.54	10.78	10.04	10.48	11.14	12.41	9.27	12.61	14.53
C3 cyclos+Olefins	:	4.52	6.80	7.60	6.37	6.96	8.93	6.29	8.33	10.06
C4 cyclos+Olefins	:	5.16	6.70	8.39	7.40	7.45	9.71	5.36	7.83	9.05
C5-C11 Paraffins	:	44.11	37.01	32.62	41.90	40.08	31.85	43.47	42.35	37.95
C5-C11 cyclos+Olefins	:	12.77	11.42	12.72	11.17	6.62	4.92	9.19	7.19	6.17
C6-C11 Aromatics	:	7.08	9.68	9.25	8.08	9.94	12.64	12.92	11.33	10.43
C12-C19 Paraffins	:	7.92	5.24	5.66	5.47	5.00	4.78	3.10	2.11	1.31
C12-C19 cyclos+Olefins	:	1.26	0.80	1.12	0.70	0.22	0.38	0.23	0.00	0.00
C12-C19 Aromatics	:	3.43	4.10	3.37	3.78	5.88	7.05	4.15	2.01	1.92
C20 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C20 cyclos+Olefins	:	1.19	0.66	1.54	0.31	0.28	0.04	0.00	0.22	0.14
C20 Aromatics	:	0.21	0.49	0.40	0.44	0.83	0.90	0.00	0.04	0.15
C21+	:	1.12	0.40	1.55	0.00	0.07	0.09	0.00	0.00	0.00

Table 3.3.1
Hydrocarbon Feedstocks
Physical Constants

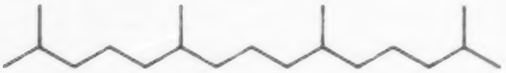
	Molecular Weight (g)	Melting Point (C)	Boilling Point (C)	Density (kg/dm3)	Refractive Index (nD20)
1-Octadecene	252.5	18	312	0.7890	1.4448
2,6,10,14-Tetramethylpentadecane	268.5		296	0.7850	1.4379
1,3,5-Triisopropylcyclohexane	210.4		254	0.8100	1.4576
1,3,5-Tri-t-Butylbenzene	246.4	72	248		
1-Phenyldodecane	246.4	2		0.8560	1.4820
Fluorene	166.2	116	294	1.2030	
9-Phenylfluorene	242.3	148			

Table 3-3-1-A

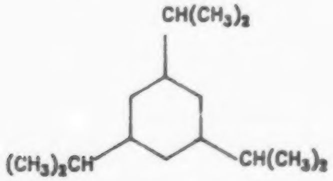
Hydrocarbon Feedstocks – Structures



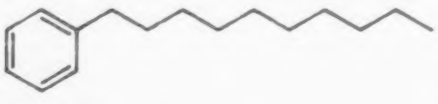
1–Octadecene



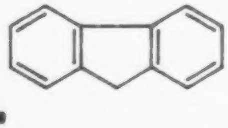
2,6,10,14–Tetramethylpentadecane



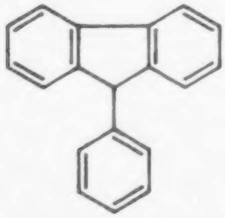
1,3,5,–Triisopropylcylohexane



1–Phenyldodecane



Fluorene



9–Phenylfluorene

Table 3.3.2
Cracking Yields for Other Hydrocarbons

		1-Octadecene			Tetramethylpentadecane			Triisopropylcyclohexane			Tri-t-Butylbenzene			1-Phenyldodecane		
Contact Time	(s)	60	100	200	60	120	200	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF																
PRODUCTS																
H2 - C2	:	1.18	1.43	1.64	0.78	1.02	1.24	0.90	1.19	1.43	0.32	0.35	0.46	0.93	1.28	1.41
C3C4	:	25.76	27.49	28.48	30.11	28.98	31.85	33.55	31.92	33.27	61.27	58.83	57.50	16.54	18.63	20.55
C5'S	:	10.62	10.74	10.50	11.34	10.42	12.33	9.79	9.03	9.53	2.81	3.27	4.62	6.12	5.54	7.52
C5 + Gasoline	:	63.70	61.43	61.06	62.80	64.81	61.15	59.74	62.73	61.59	33.34	34.84	36.83	64.20	60.00	58.35
C6 + Gasoline	:	53.08	50.69	50.56	51.46	54.39	48.82	49.95	53.69	52.06	30.54	31.57	32.21	58.08	53.46	50.84
Light Cycle Oil	:	5.60	5.09	3.95	3.91	2.17	2.17	4.14	2.42	2.05	1.14	1.09	1.13	14.58	15.01	14.22
Decant Oil	:	0.51	0.70	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58	2.08	1.91
Coke	:	3.25	3.85	4.35	2.39	3.02	3.58	1.68	1.75	1.66	3.93	4.90	4.09	2.17	3.00	3.45
Conversion	:	93.89	94.21	95.52	96.09	97.83	97.83	95.86	97.58	97.95	98.86	98.91	98.87	83.84	82.91	83.87
COMPOSITIONAL YIELDS - mass %FF																
COMPONENTS																
Hydrogen	:	0.05	0.06	0.07	0.01	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.05	0.09	0.13
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23	1.03	0.84	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.27	0.23
Carbon Dioxide	:	0.14	0.15	0.15	0.23	0.20	0.19	0.21	0.23	0.25	0.46	0.41	0.37	0.29	0.32	0.33
Methane	:	0.40	0.48	0.55	0.29	0.38	0.47	0.23	0.28	0.32	0.30	0.33	0.44	0.16	0.23	0.29
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.33	0.41	0.48	0.20	0.27	0.38	0.44	0.60	0.73	0.00	0.00	0.00	0.20	0.32	0.34
Ethane	:	0.40	0.47	0.54	0.28	0.33	0.37	0.22	0.29	0.34	0.00	0.00	0.00	0.24	0.35	0.41
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propane	:	7.56	7.85	8.52	7.85	7.47	7.98	6.34	4.62	4.85	2.01	2.51	4.05	3.49	3.75	3.95
Propene	:	0.98	1.32	1.34	0.71	1.00	1.38	2.14	3.22	3.86	0.00	0.00	0.00	1.91	2.59	2.97
1,3-Butadiene	:	0.08	0.06	0.08	0.07	0.06	0.05	0.03	0.02	0.02	0.02	0.06	0.06	0.02	0.03	0.02
Butenes	:	8.31	7.88	8.11	7.91	7.04	7.06	2.63	1.58	1.46	42.71	37.92	29.27	2.28	2.03	2.08
n-Butane	:	2.16	2.50	2.48	2.60	2.71	2.96	2.43	2.98	3.23	0.88	0.95	1.45	3.33	3.83	4.29
i-Butane	:	6.92	7.92	8.28	10.98	10.79	12.45	19.93	19.45	20.17	14.17	16.11	21.85	5.69	6.39	7.55
cycloPentene	:	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	:	4.81	5.90	4.92	3.75	3.13	2.82	0.64	0.48	0.34	1.72	1.71	2.24	0.58	0.39	0.53
n-Pentane	:	1.83	1.80	1.84	1.90	1.77	2.03	1.88	1.63	1.76	0.45	0.58	0.69	1.50	1.59	1.66
i-Pentane	:	8.71	8.93	7.14	8.19	8.08	9.80	8.24	8.06	8.38	0.86	1.02	2.52	6.09	6.29	7.14
Thiophene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	0.06	0.05	0.17	0.16	0.14	0.10	1.02	1.15	1.27	10.80	11.72	14.02	3.44	4.30	3.58
C6 cycloOlefins	:	0.00	0.00	0.00	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	4.40	4.85	5.32	3.19	2.64	2.15	1.37	1.53	1.63	1.37	0.98	0.67	0.61	0.35	0.61
Hexanes	:	3.58	5.24	3.83	4.30	5.98	6.00	3.87	4.38	4.63	0.62	0.53	0.81	4.60	4.36	4.97
Toluene	:	0.35	0.82	0.94	0.75	0.84	0.88	1.49	1.88	2.24	1.96	2.21	2.69	2.04	2.22	1.88
C7 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.27	0.21	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	:	4.05	2.29	2.05	1.98	1.63	1.38	3.80	4.35	4.08	0.16	0.29	0.36	1.21	1.18	0.89
Heptanes	:	7.01	6.01	7.10	6.73	6.25	6.87	3.29	3.58	3.48	0.09	0.08	0.44	4.75	5.77	4.58
C8 alkylBenzenes	:	4.58	5.30	6.42	1.80	2.87	3.75	4.73	6.22	7.13	1.48	2.70	3.16	3.54	4.35	4.17
C8 cycloOlefins	:	0.06	0.00	0.00	0.06	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	1.82	1.88	1.16	0.91	1.11	0.74	2.55	2.84	1.64	0.82	0.58	0.38	0.83	1.11	0.88
Octanes	:	4.81	5.08	4.48	6.53	5.85	5.82	1.59	1.18	1.88	0.16	0.09	0.36	5.60	5.68	4.85
Indenes	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.95	2.77	2.42
C9 alkylBenzenes	:	6.57	5.79	6.80	2.16	4.88	3.50	7.33	8.74	9.35	1.21	1.43	3.78	3.56	4.02	3.97
C9 cycloOlefins	:	0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.58	0.48	0.33	0.45	0.33	0.25	1.81	0.60	0.32	0.00	0.03	0.00	0.08	0.00	0.00
Nonanes	:	2.28	1.84	2.06	5.79	4.88	3.31	0.43	0.32	0.16	0.00	0.00	0.00	4.54	3.32	2.96
C10 Aromatics	:	4.81	4.37	4.85	2.27	3.98	3.01	6.86	8.80	7.18	8.58	7.10	3.05	13.32	10.11	10.56
C10 Olefins	:	0.53	0.06	0.00	0.11	0.00	0.00	0.88	0.32	0.16	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	:	0.35	0.22	0.17	3.98	3.16	2.91	0.11	0.11	0.11	0.00	0.00	0.00	1.44	0.69	1.14
C11 Aromatics	:	3.58	3.22	3.04	0.97	1.98	1.78	5.16	3.92	3.22	0.37	1.21	0.73	6.65	7.00	5.94
C11 Olefins	:	0.16	0.00	0.00	0.06	0.08	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	:	0.41	0.16	0.00	2.50	1.83	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.28	0.81
C12 Aromatics	:	2.88	2.51	0.88	1.38	1.88	1.63	1.81	1.77	1.80	0.40	0.53	0.98	3.78	4.85	4.50
C12 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.11	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	:	0.18	0.16	0.00	2.33	1.05	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.83	0.61
C13 Aromatics	:	1.11	1.04	0.83	0.80	1.00	1.13	1.22	1.29	1.43	1.46	0.84	0.85	1.67	2.22	2.10
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.00	0.00	0.00	1.14	0.44	0.35	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Aromatics	:	1.23	0.71	0.72	0.88	0.36	0.88	0.80	0.64	0.58	0.31	1.15	0.18	1.81	1.80	1.41
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.00	0.00	0.00	0.97	0.17	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	:	0.18	0.33	0.00	0.40	0.28	0.25	0.32	0.21	0.32	0.00	0.22	0.04	1.74	0.83	0.68
C15 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	2.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
C16 Aromatics	:	0.00	0.00	0.00	0.34	0.17	0.20	0.11	0.11	0.18	0.03	0.08	0.04	1.06	0.28	0.67
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	:	0.00	0.00	0.00	0.08	0.28	0.15	0.00	0.05	0.06	0.08	0.03	0.00	1.14	0.21	0.33
C17 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	:	0.58	0.33	0.17	0.00	0.08	0.00	0.00	0.00	0.00	1.58	0.82	0.00	0.23	0.00	0.20

Table 3.3.2(con't)
Cracking Yields for Other Hydrocarbons

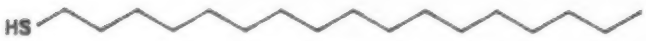
	Fluorene			9-Phenylfluorene		
Contact Time (s)	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF						
PRODUCTS						
H2 - C2	0.08	0.00	0.00	0.03	0.00	0.01
C3C4	0.62	0.91	0.50	0.27	0.36	0.87
C5'S	0.08	0.30	0.17	0.19	0.19	0.11
C5 + Gasoline	0.16	0.39	0.21	12.60	14.97	15.87
C6 + Gasoline	0.08	0.09	0.05	12.41	14.78	15.77
Light Cycle Oil	97.81	96.11	96.17	84.48	80.80	78.47
Decant Oil	0.00	0.00	0.00	0.95	1.90	1.90
Coke	1.53	2.58	3.12	1.58	1.98	2.88
Conversion	2.39	3.89	3.83	14.57	17.30	19.63
COMPOSITIONAL YIELDS - mass %FF						
COMPONENTS						
Hydrogen	0.08	0.00	0.00	0.03	0.00	0.01
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.00	0.00	0.00	0.00	0.00	0.00
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	0.00	0.00	0.00	0.00	0.00	0.00
Ethane	0.00	0.00	0.00	0.00	0.00	0.00
Propyne	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00
Propene	0.08	0.04	0.02	0.03	0.04	0.04
Propene	0.08	0.04	0.02	0.00	0.00	0.01
1,3-Butadiene	0.00	0.00	0.00	0.00	0.00	0.00
Butenes	0.31	0.62	0.33	0.14	0.15	0.11
n-Butane	0.00	0.00	0.00	0.03	0.04	0.02
i-Butane	0.14	0.22	0.12	0.08	0.13	0.08
cycloPentene	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	0.00	0.00	0.00	0.00	0.00	0.00
n-Pentane	0.00	0.00	0.00	0.00	0.00	0.00
i-Pentane	0.08	0.30	0.17	0.19	0.19	0.11
Thiophene	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	0.08	0.09	0.05	2.85	2.38	1.00
C6 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	0.00	0.00	0.00	0.00	0.00	0.00
Hexanes	0.00	0.00	0.00	0.00	0.00	0.00
Toluene	0.00	0.00	0.00	0.05	0.08	0.02
C7 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	0.00	0.00	0.00	0.00	0.00	0.00
Heptanes	0.00	0.00	0.00	0.00	0.00	0.00
C8 alkylBenzenes	0.00	0.00	0.00	0.00	0.00	0.00
C8 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	0.00	0.00	0.00	0.00	0.00	0.00
Octanes	0.00	0.00	0.00	0.00	0.00	0.00
Indenes	0.00	0.00	0.00	0.00	0.00	0.00
C9 alkylBenzenes	0.00	0.00	0.00	0.00	0.00	0.00
C9 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	0.00	0.00	0.00	0.00	0.00	0.00
Nonanes	0.00	0.00	0.00	0.00	0.00	0.00
C10 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C10 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C11 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C11 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C12 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C12 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C13 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C13 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C14 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C14 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C15 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C15 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C16 Olefins	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	0.00	0.00	0.00	0.00	0.00	0.00
C17 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00
C18+	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.4.1
Major Sulfur and Nitrogen Feedstocks
Physical Constants

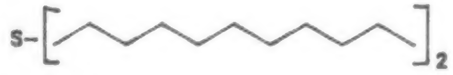
	Molecular Weight (g)	Melting Point (C)	Boilling Point (C)	Density (kg/dm3)	Refractive Index (nD20)
1-Octadecanethiol	286.6	30	340	0.8475	1.4645
Undecyl Sulfide	342.0	35		0.8462	
Octyl Sulfide	258.5		325	0.8400	1.4610
Dibenzothiophene	184.3	100	332		
2,6-Di-t-Butyl-4-Methylpyridine	205.4	34	233		1.4763
9-Phenylcarbazole	243.3	95			1.4763

Table 3·4·1·A

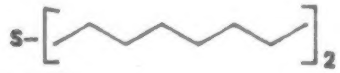
Major Sulfur and Nitrogen Feedstocks



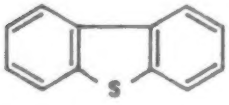
1-Octadecanethiol



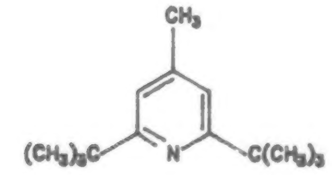
Undecyl Sulfide



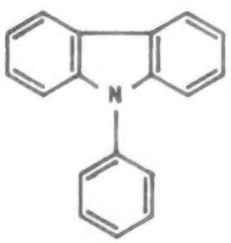
Octyl Sulfide



Dibenzothiophene



2,6-Di-t-Butyl-4-Methylpyridine



9-Phenylcarbazole

Table 3.4.2
Cracking Yields for Major Sulfur and Nitrogen Species

MICROACTIVITY TEST-Yield Stuctures mass %FF

	Octadecanethiol			Undecyl Sulfide			Octyl Sulfide			Dibenzothiophene			Di-t-Butyl-Methylpyridine			9-Phenylcarbazole		
Contact Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
PRODUCTS																		
H2 - C2	7.60	8.51	8.79	9.11	8.74	9.57	14.53	12.99	13.04	0.03	0.12	1.03	0.50	0.67	0.48	0.07	0.04	0.04
C3C4	25.59	25.57	28.60	26.82	23.27	28.27	28.57	25.85	28.57	0.77	1.65	2.83	4.47	3.64	4.41	0.86	0.54	0.96
C5'S	11.78	10.53	10.41	9.70	9.75	10.77	9.57	9.28	9.71	0.40	0.73	0.00	0.75	0.94	1.20	0.10	0.06	1.27
C5 + Gasoline	56.75	55.89	53.68	52.15	55.15	51.72	52.02	55.21	52.68	1.00	1.81	0.00	2.30	1.21	2.75	2.98	4.12	7.57
C8 + Gasoline	44.97	45.25	43.26	42.45	45.40	40.95	42.35	45.93	42.97	0.60	1.08	0.00	1.55	0.27	1.55	2.88	4.06	6.30
Light Cycle Oil	5.79	5.81	5.46	6.52	7.12	6.79	1.17	1.22	1.23	95.31	93.17	90.81	91.00	92.44	90.11	94.03	92.62	87.70
Decant Oil	1.27	0.98	0.00	1.16	1.50	0.98	0.00	0.00	0.00	0.00	0.00	2.52	0.00	0.00	0.00	0.00	0.00	0.00
Coke	3.03	3.23	3.37	4.23	4.23	4.67	3.71	3.73	4.38	2.88	3.25	2.77	1.73	2.02	2.26	2.05	2.69	3.72
Conversion	92.97	93.21	94.45	92.32	91.38	92.23	98.83	98.78	98.77	4.69	6.83	6.67	9.00	7.56	9.89	5.97	7.38	12.30

COMPOSITIONAL YIELDS - mass %FF

	Octadecanethiol			Undecyl Sulfide			Octyl Sulfide			Dibenzothiophene			Di-t-Butyl-Methylpyridine			9-Phenylcarbazole		
Contact Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
COMPONENTS																		
Hydrogen	0.11	0.12	0.12	0.13	0.13	0.12	0.08	0.07	0.08	0.00	0.00	0.30	0.04	0.03	0.03	0.03	0.02	0.04
Carbon Monoxide	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.58	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	6.01	6.90	7.04	5.87	5.54	5.88	12.18	10.84	10.58	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
Carbon Dioxide	0.54	0.51	0.52	0.92	0.85	0.98	0.41	0.37	0.38	0.31	0.41	0.80	0.32	0.46	0.37	0.00	0.00	0.00
Methane	0.48	0.52	0.57	0.95	0.82	1.08	0.52	0.45	0.52	0.03	0.07	0.70	0.38	0.48	0.37	0.03	0.02	0.00
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	0.28	0.28	0.34	1.05	0.94	1.08	0.48	0.00	0.52	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethane	0.63	0.80	0.82	1.14	1.08	1.24	1.18	1.54	1.23	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00
Propyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	7.22	6.90	7.48	8.22	6.91	7.42	8.22	7.71	8.12	0.00	0.00	0.00	0.28	0.00	0.08	0.03	0.02	0.04
Propene	1.38	1.84	1.78	2.30	2.22	2.90	1.53	1.38	1.85	0.17	0.31	0.00	0.28	0.28	0.28	0.07	0.04	0.08
1,3-Butadiene	0.05	0.03	0.05	0.08	0.04	0.04	0.11	0.08	0.10									
Butenes	6.76	6.95	8.85	4.83	3.86	3.83	9.91	9.77	9.40									
n-Butane	2.57	2.33	3.18	3.14	3.03	3.84	2.83	0.00	2.88									
i-Butane	7.28	6.90	7.04	7.82	6.92	7.97	6.08	7.82	6.44									
cycloPentene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
Pentenes	2.92	2.58	2.41	1.00	1.02	0.95	3.88	3.94	3.10									
n-Pentane	2.18	1.82	1.58	1.86	1.88	2.08	1.41	0.00	1.38									
i-Pentane	8.02	7.47	7.81	7.34	7.48	8.06	5.71	6.53	6.08									
Thiophene	0.00	0.00	0.00	0.84	0.58	0.83	0.27	0.28	0.27									
Thiacyclopentene	0.00	0.00	0.00	0.24	0.21	0.05	0.10	0.08	0.02									
Benzene	0.23	0.18	0.22	0.21	0.16	0.23	0.21	0.23	0.23									
C6 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
Hexenes	2.11	1.88	1.88	1.55	1.48	1.53	1.78	1.71	1.81									
Hexanes	5.45	4.71	4.41	3.93	3.98	4.08	2.18	1.81	2.10									
Toluene	1.11	0.94	1.31	2.18	1.88	2.54	0.48	0.50	0.88									
C7 cycloOlefins	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00									
Heptenes	1.37	1.07	1.45	2.35	1.92	2.41	0.82	1.45	1.35									
Heptanes	5.41	6.08	4.48	3.39	3.74	2.95	1.75	1.38	1.30									
C8 alkylBenzenes	3.38	3.18	3.91	5.48	5.38	6.28	5.47	5.20	5.08									
C8 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
Octenes	1.18	1.20	0.91	1.27	1.32	0.97	1.17	4.07	2.11									
Octanes	4.35	3.91	3.13	1.52	1.37	1.07	18.80	24.38	25.25									
Indenes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C9 alkylBenzenes	4.35	4.48	4.88	5.48	5.85	6.04	2.97	2.80	2.11									
C9 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
Nonenes	0.00	0.00	0.00	0.15	0.18	0.10	0.04	0.05	0.08									
Nonanes	3.84	3.53	5.02	0.34	0.32	0.44	0.00	0.00	0.00									
C10 Aromatics	2.83	3.71	3.97	2.84	3.48	3.28	2.21	1.00	0.25									
C10 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C10 Paraffins	2.28	1.75	1.45	0.10	0.00	0.00	0.00	0.00	0.00									
C11 Aromatics	2.28	3.32	2.18	7.34	9.50	6.52	1.28	0.38	0.17									
C11 Olefins	0.00	0.00	0.00	0.73	0.37	0.34	0.00	0.00	0.00									
C11 Paraffins	2.33	2.23	1.54	3.23	3.11	2.08	0.00	0.00	0.00									
C12 Aromatics	2.02	2.15	2.48	2.88	3.22	3.38	1.17	0.32	0.17									
C12 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C12 Paraffins	1.42	1.28	1.22	0.00	0.00	0.00	0.00	0.00	0.00									
C13 Aromatics	1.11	2.02	1.44	1.88	2.38	1.90	0.28	0.08	0.08									
C13 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C13 Paraffins	0.91	0.92	1.00	0.00	0.00	0.00	0.00	0.00	0.00									
C14 Aromatics	0.56	0.74	0.40	0.88	1.21	0.83	0.13	0.05	0.04									
C14 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C14 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C15 Aromatics	0.40	0.38	0.23	0.84	0.83	0.28	0.00	0.00	0.00									
C15 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C15 Paraffins	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00									
C16 Aromatics	0.10	0.11	0.10	0.29	0.32	0.19	0.00	0.00	0.00									
C16 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
C16 Paraffins	0.20	0.22	0.24	0.00	0.00	0.00	0.00	0.00	0.00									
C17 Aromatics	0.00	0.00	0.00	0.24	0.21	0.10	0.00	0.00	0.00									
C17 Paraffins	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00									
C18+	1.08	0.50	0.00	0.10	0.11	0.08	0.00	0.00	0.00									

Table 3.5.1
Effects of Nitrogen Poisoning
Feedstock Nitrogen as ppm Nitrogen

FEEDSTOCK	NITROGEN CONCENTRATION	
	TARGET	ACTUAL
Blend A	400	394
	800	811
	1600	1610
	3200	3180
Blend B	400	412
	800	803
	1600	1580
	3200	3190
Blend C	400	410
	800	795
	1600	1580
	3200	3220

Table 3.5.2
Effects of Nitrogen Poisoning on Cracking Catalyst

		Blend A					Blend B					Blend C				
Feed Nitrogen	(ppm)	0	400	800	1600	3200	0	400	800	1600	3200	0	400	800	1600	3200
MICROACTIVITY TEST - Yield Stuctures mass %FF																
PRODUCTS																
H2 - C2	:	2.70	2.31	2.76	2.09	3.19	0.86	0.43	0.60	0.28	0.43	0.91	0.70	1.41	0.46	0.34
C3C4	:	23.44	23.04	22.44	17.18	18.37	26.30	20.83	22.20	13.36	12.79	22.72	21.15	20.73	15.55	9.93
C5'S	:	10.43	10.15	9.94	8.18	7.77	11.75	9.75	9.00	7.22	4.59	10.01	9.26	11.02	6.88	5.08
C5 + Gasoline	:	56.75	55.62	54.60	52.61	49.06	55.70	55.74	45.97	40.90	25.40	55.73	56.67	55.26	44.58	33.99
C6 + Gasoline	:	46.32	45.47	44.66	44.43	41.29	43.95	45.99	36.96	33.68	20.81	45.72	48.41	44.24	37.69	28.32
Light Cycle Oil	:	10.76	12.15	13.71	20.35	20.62	12.66	18.75	26.79	40.95	55.95	15.54	15.74	18.32	34.73	50.42
Decant Oil	:	2.38	3.48	3.47	5.45	6.08	1.96	2.51	3.05	3.38	4.61	2.46	2.38	2.44	3.72	4.49
Coke	:	3.97	3.41	3.01	2.31	2.67	2.53	1.70	1.39	1.13	0.81	2.64	2.35	1.85	0.96	0.93
Conversion	:	86.86	84.37	82.82	74.20	73.29	85.38	78.74	70.16	55.67	39.44	82.00	81.88	79.24	61.55	45.09
COMPOSITIONAL YIELDS - mass %FF																
COMPONENTS																
Hydrogen	:	0.15	0.17	0.13	0.13	0.24	0.03	0.03	0.04	0.04	0.06	0.04	0.06	0.05	0.07	0.05
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	1.58	0.82	1.57	1.09	1.40	0.19	0.00	0.00	0.00	0.00	0.19	0.00	0.88	0.00	0.00
Carbon Dioxide	:	0.39	0.82	0.54	0.70	0.60	0.38	0.16	0.20	0.10	0.13	0.31	0.16	0.18	0.13	0.07
Methane	:	0.29	0.33	0.26	0.21	0.39	0.21	0.12	0.14	0.09	0.10	0.19	0.19	0.15	0.10	0.09
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.22	0.34	0.25	0.20	0.38	0.14	0.08	0.18	0.01	0.11	0.19	0.16	0.09	0.10	0.06
Ethane	:	0.43	0.60	0.51	0.41	0.73	0.29	0.20	0.24	0.13	0.16	0.28	0.28	0.24	0.19	0.14
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	6.23	6.22	6.31	4.92	4.84	5.54	4.66	5.10	3.23	3.28	4.77	4.66	4.95	3.74	2.59
Propane	:	1.37	1.51	1.22	0.88	1.57	1.48	0.85	1.00	0.52	0.58	1.45	1.34	1.05	0.77	0.50
1,3-Butadiene	:	0.06	0.05	0.08	0.05	0.05	0.03	0.03	0.04	0.04	0.03	0.03	0.02	0.06	0.04	0.06
Butenes	:	5.66	5.78	6.46	5.07	5.03	4.25	3.75	3.65	2.81	2.31	3.41	3.44	3.73	3.24	2.45
n-Butane	:	2.84	2.74	2.46	1.85	2.13	2.99	2.17	2.36	1.44	1.25	3.19	2.82	2.64	1.81	1.10
i-Butane	:	7.11	6.24	5.71	3.99	4.40	11.77	9.26	10.03	5.45	5.24	9.67	8.90	8.19	5.87	3.17
cycloPentene	:	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	:	1.57	2.89	3.36	3.03	2.40	1.03	1.48	1.98	0.98	1.54	0.70	1.21	1.46	1.86	1.26
n-Pentane	:	1.87	2.04	1.78	1.55	1.24	2.12	1.76	1.85	1.36	1.11	1.98	1.81	2.43	1.45	0.91
i-Pentane	:	7.13	7.11	6.86	5.32	4.57	9.41	7.67	7.46	5.35	4.32	8.38	8.16	9.09	5.86	3.24
Thiophene	:	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	0.88	0.80	0.47	0.47	0.55	0.92	0.96	1.02	1.30	0.95	1.42	0.94	1.63	1.44	1.27
C6 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	1.23	2.83	3.58	3.58	3.39	1.32	1.55	2.53	1.58	1.64	1.17	1.82	2.34	2.63	3.12
Hexanes	:	2.71	5.03	4.47	4.19	3.29	4.67	4.27	4.75	4.95	4.58	4.72	6.27	6.74	5.22	2.35
Toluene	:	0.98	0.81	0.85	1.00	0.72	0.91	0.87	0.80	0.63	0.75	1.56	0.46	0.67	0.96	1.24
C7 cycloOlefins	:	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.13	0.32	0.00
Heptenes	:	1.23	1.37	1.83	1.86	2.52	1.77	2.14	2.07	2.82	2.08	2.19	2.88	3.46	4.33	4.08
Heptanes	:	3.39	4.98	4.50	5.11	4.04	4.79	4.59	4.66	4.46	4.34	5.02	5.75	7.67	6.45	3.71
C8 alkylBenzenes	:	3.26	2.43	2.30	2.85	3.10	2.98	2.75	2.41	2.38	2.00	4.18	1.70	1.48	3.68	2.75
C8 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	0.98	1.80	2.18	3.01	4.25	1.77	1.94	2.01	2.12	2.08	2.12	4.85	2.28	3.12	2.92
Octanes	:	4.80	8.77	8.72	10.61	8.07	4.48	4.42	3.88	4.79	2.98	5.68	4.65	6.11	6.49	4.08
Indenes	:	0.74	0.50	0.58	0.72	0.65	0.91	1.01	1.14	0.83	0.08	1.50	1.44	0.67	0.96	1.42
C9 alkylBenzenes	:	2.77	2.30	2.18	2.85	2.81	3.32	3.02	3.08	3.53	2.66	4.43	2.03	2.48	2.40	2.57
C9 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.00	0.50	0.41	0.79	1.15	0.23	0.47	0.87	0.63	0.33	0.44	0.26	0.60	0.96	0.62
Nonanes	:	2.03	3.11	3.00	3.87	3.24	3.03	3.89	2.81	3.22	1.41	3.66	3.41	3.09	3.77	3.28
C10 Aromatics	:	5.54	6.78	6.42	6.45	7.35	5.37	5.63	5.82	6.44	3.74	8.16	6.94	6.38	6.57	8.42
C10 Olefins	:	0.00	0.88	0.88	1.51	1.01	0.11	0.00	0.40	0.00	0.50	0.00	0.20	0.27	0.56	0.62
C10 Paraffins	:	2.15	1.93	2.00	2.58	2.23	1.86	3.89	2.07	2.59	1.33	1.62	1.44	2.15	2.24	1.24
C11 Aromatics	:	4.68	0.75	0.53	0.93	0.94	4.46	7.10	5.02	5.81	2.66	5.12	5.31	4.50	3.20	7.44
C11 Olefins	:	0.00	0.75	0.41	0.72	1.01	0.00	0.00	0.13	0.24	0.42	0.00	0.13	0.20	0.32	0.09
C11 Paraffins	:	1.54	1.87	2.00	2.72	2.09	2.17	3.28	1.34	2.67	0.42	0.56	1.18	1.14	1.28	1.24
C12 Aromatics	:	2.95	2.55	1.88	2.01	2.30	2.69	1.34	2.21	2.98	1.58	2.87	2.42	1.54	1.04	3.81
C12 Olefins	:	0.00	0.56	0.65	0.72	0.29	0.00	0.00	0.07	0.00	0.33	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	:	2.15	1.00	1.35	1.51	1.66	0.23	2.41	0.67	1.18	0.33	0.25	0.46	0.81	0.96	0.71
C13 Aromatics	:	2.40	1.56	1.94	1.36	1.22	1.77	2.48	1.47	1.96	1.25	1.19	2.49	1.54	1.84	2.66
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.00	0.68	0.65	0.57	0.86	0.40	0.34	0.27	0.39	0.00	0.00	0.13	0.13	0.32	0.27
C14 Aromatics	:	3.45	1.80	1.53	0.57	1.15	1.86	1.14	1.54	1.57	1.08	1.25	2.03	1.01	1.76	1.68
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.00	0.31	0.06	0.22	0.22	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	:	2.22	0.93	0.24	0.57	0.38	0.97	0.80	0.20	0.47	0.17	0.87	0.92	0.54	0.56	0.44
C15 Olefins	:	0.00	0.00	0.00	0.00	0.00	3.32	3.08	4.35	6.83	14.30	1.58	1.57	2.08	4.01	6.95
C15 Paraffins	:	0.00	0.00	0.12	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	:	2.09	0.31	0.18	0.07	0.14	0.86	0.27	0.13	0.24	0.17	0.56	0.92	0.13	0.08	0.27
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.37	0.00	0.29	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	:	1.42	0.25	0.24	0.14	0.07	0.57	0.27	0.13	0.24	0.17	0.44	0.98	0.20	0.16	0.35
C17 Paraffins	:	0.31	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	:	2.65	1.18	3.24	4.73	6.34	0.46	2.01	6.02	10.91	24.62	0.00	0.85	1.01	6.17	11.76

Table 3.5.3
Effects of Nitrogen Poisoning on Cracking Catalyst
Analytical MAT Yields

	Blend A					Blend B					Blend C				
Feed Nitrogen (ppm)	0	400	800	1600	3200	0	400	800	1600	3200	0	400	800	1600	3200
Yield Stuctures mass %FF															
PRODUCTS															
H2	0.15	0.17	.0.13	0.13	0.24	0.03	0.03	0.04	0.04	0.06	0.04	0.06	0.05	0.07	0.05
H2 - C2	2.52	2.08	2.59	1.91	2.89	0.82	0.40	0.55	0.24	0.37	0.86	0.64	1.35	0.39	0.29
C3C4	23.40	22.54	22.24	16.77	18.02	26.05	20.73	22.18	13.30	12.70	22.52	21.18	20.63	15.47	9.89
C5'S	10.58	12.04	11.81	9.92	8.20	12.55	10.91	11.28	7.66	6.97	11.05	11.18	12.98	9.17	5.41
C5 + Gasoline	49.57	59.84	58.94	65.34	60.60	57.43	62.70	58.55	58.41	41.93	64.64	62.83	66.96	66.08	57.86
C6 + Gasoline	38.99	47.79	47.13	55.42	52.40	44.87	51.78	47.27	50.75	34.96	53.59	51.65	53.98	56.91	52.45
Light Cycle Oil + Decant	20.00	11.14	12.55	12.83	14.98	12.75	14.27	17.05	26.77	43.99	8.99	12.77	8.99	16.90	30.92
Coke	3.97	3.41	3.01	2.31	2.67	2.53	1.70	1.39	1.13	0.81	2.64	2.35	1.85	0.96	0.93
Conversion	80.00	88.86	87.45	87.17	85.02	87.25	85.73	82.95	73.23	56.01	91.01	87.23	91.01	83.10	69.08
C4/C3	2.08	1.92	1.95	1.89	1.81	2.72	2.76	2.64	2.55	2.28	2.62	2.53	2.43	2.43	2.20
Propene/Propane	4.55	4.11	5.17	5.58	3.09	3.80	5.46	5.08	6.26	5.65	3.28	3.47	4.70	4.84	5.20
Butenes/Butanes	0.57	0.64	0.79	0.87	0.77	0.29	0.33	0.29	0.38	0.36	0.27	0.29	0.34	0.42	0.57
i-Butane/Butenes	1.26	1.08	0.89	0.79	0.88	2.77	2.47	2.75	2.08	2.26	2.84	2.59	2.19	1.81	1.29
i-Butene/Butanes	0.71	0.69	0.70	0.68	0.67	0.80	0.81	0.81	0.79	0.81	0.75	0.76	0.76	0.76	0.74
i-Pentane/Pentanes	0.79	0.78	0.79	0.77	0.79	0.82	0.81	0.80	0.80	0.80	0.81	0.82	0.79	0.80	0.78
Selectivities															
C3C4	0.29	0.25	0.25	0.19	0.21	0.30	0.24	0.27	0.18	0.23	0.25	0.24	0.23	0.19	0.14
C5+Gasoline	0.62	0.67	0.67	0.75	0.71	0.66	0.73	0.71	0.80	0.75	0.71	0.72	0.74	0.80	0.84
C6+Gasoline	0.49	0.54	0.54	0.64	0.62	0.51	0.60	0.57	0.69	0.62	0.59	0.59	0.59	0.68	0.76
LCO + DO	0.25	0.13	0.14	0.15	0.18	0.15	0.17	0.21	0.37	0.79	0.10	0.15	0.10	0.20	0.45
Coke	0.05	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.03	0.03	0.02	0.01	0.01

Table 3.6.1
Key Component Blends and Synergistic Effects
Compositions

	Blend A
50.0%	Dotriacontane
25.0%	1-Phenyldodecane
12.5%	1-Octadecanethiol
12.5%	Octyl Sulfide

	Blend B
40.0%	2,6,10,14-Tetramethylpentadecane
30.0%	1,3,5-Triisopropylcyclohexane
30.0%	1-Phenyldodecane

	Blend C
50.0%	1-Phenyldodecane
25.0%	1,3,5-Triisopropylcyclohexane
25.0%	1-Octadecene

Table 3.6.2
Key Component Blends and Synergistic Effects
Experimental MAT Data

	BLEND A			BLEND B			BLEND C		
Contact Time (s)	60	120	200	60	120	200	60	120	200
Microactivity Test Data									
C2+LIQ	2.70	3.19	3.50	1.99	2.07	1.68	1.09	1.14	1.68
C3C4	23.44	24.40	25.49	31.16	32.99	31.39	23.60	24.42	26.15
C5'S	10.43	10.41	10.83	11.27	12.66	12.20	8.08	10.40	10.46
C5+GAS	56.75	55.44	54.85	53.64	52.29	54.29	56.49	55.83	52.86
C6+GAS	46.32	45.03	44.02	42.36	39.63	42.09	48.40	45.43	42.40
LCO	10.76	9.78	8.40	8.02	7.57	7.61	13.59	13.17	13.32
DECANT	2.38	2.64	2.18	1.26	1.04	1.01	1.80	2.02	1.92
COKE	3.97	4.55	5.58	3.93	4.04	4.02	3.43	3.42	4.06
Reactor Effluent Composition									
Hydrogen	0.15	0.18	0.24	0.09	0.15	0.13	0.13	0.05	0.10
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	1.58	1.77	1.72	0.01	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.39	0.43	0.52	0.27	0.24	0.30	0.18	0.17	0.21
Methane	0.29	0.38	0.46	0.71	0.82	0.54	0.37	0.39	0.51
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	0.22	0.28	0.35	0.58	0.56	0.45	0.17	0.31	0.53
Ethane	0.43	0.56	0.69	0.58	0.54	0.54	0.41	0.38	0.54
Propyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	6.23	6.43	6.58	8.31	7.88	6.65	5.11	5.91	5.85
Propane	1.37	1.64	1.93	2.63	2.81	2.56	2.50	2.12	2.83
1,3-Butadiene	0.06	0.05	0.05	0.04	0.03	0.04	0.02	0.03	0.00
Butenes	5.66	5.64	5.54	5.16	5.04	4.06	2.82	3.65	3.15
n-Butane	2.84	3.08	3.30	3.39	4.02	3.95	3.24	3.37	3.90
i-Butane	7.11	7.42	7.88	11.60	13.11	14.04	9.86	9.36	10.31
C5 Cyclos+Olefins	1.57	1.70	1.96	1.24	1.21	0.85	0.49	0.81	0.77
n-Pentane	1.87	2.01	2.21	2.53	1.84	2.22	1.50	1.95	2.11
i-Pentane	7.13	7.78	8.28	8.83	10.18	9.94	6.38	7.90	8.25
Thiophene	0.12	0.06	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	0.88	0.76	0.65	2.32	1.87	1.53	2.43	2.31	2.45
C6 Cyclos+Olefins	1.23	1.29	1.53	1.10	0.92	0.76	1.13	0.81	0.77
Hexanes	2.71	4.26	4.52	4.35	3.55	4.38	2.48	2.59	3.12
Toluene	0.98	0.81	0.90	1.99	2.09	1.58	2.14	1.99	2.20
C7 Cyclos+Olefins	1.29	1.28	1.21	1.28	1.16	1.35	2.46	1.39	1.17
Heptanes	3.39	4.65	5.12	4.41	2.04	3.83	1.97	2.77	2.11
C8 alkylBenzenes	3.26	2.27	2.91	4.72	4.96	3.59	4.92	4.49	4.74
C8 cycloOlefins	0.98	0.70	0.90	0.55	0.65	0.50	1.10	0.91	0.79
Octanes	4.80	7.97	6.92	2.68	1.58	3.74	2.46	2.24	1.86
C9 Aromatics	3.51	2.79	2.69	5.02	5.61	4.89	5.89	5.75	5.70
C9 Cyclos+Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.06
Nonanes	2.03	3.31	1.95	1.04	0.93	2.34	1.30	1.27	0.79
C10 Aromatics	5.54	3.78	3.28	5.61	6.31	5.24	7.45	7.64	7.84
C10 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	2.15	2.15	2.01	0.84	0.51	1.25	0.39	0.79	0.34
C11 Aromatics	4.68	3.37	3.06	4.82	4.73	4.24	7.64	7.40	6.54
C11 Olefins	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	1.54	1.80	1.53	0.40	0.19	1.00	1.62	0.97	0.17
C12 Aromatics	2.95	2.33	2.11	2.43	2.97	2.39	5.12	4.55	4.91
C12 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	2.15	1.45	1.11	0.15	0.14	0.50	0.45	0.36	0.11
C13 Aromatics	2.40	1.57	1.16	1.44	1.72	1.60	3.11	3.09	2.76
C13 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	0.00	0.58	0.26	0.00	0.05	0.00	0.00	0.00	0.00
C14 Aromatics	3.45	1.86	1.85	1.19	1.16	1.25	2.14	2.18	1.58
C14 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	0.00	0.29	0.42	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	2.22	1.57	1.43	0.75	1.07	1.15	1.88	2.06	1.86
C15 Olefins	0.00	0.00	0.00	1.49	1.35	0.90	1.81	1.21	1.52
C15 Paraffins	0.00	0.17	0.37	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	2.09	1.45	1.32	0.65	1.30	0.85	1.55	1.64	1.35
C16 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	0.37	0.17	0.26	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	1.42	1.45	1.27	0.50	0.46	0.55	1.10	1.15	1.02
C17 Paraffins	0.31	0.23	0.16	0.00	0.00	0.00	0.00	0.00	0.00
C18+	2.65	1.57	1.69	0.35	0.46	0.30	0.84	0.48	1.13
COKE	3.97	4.55	5.58	3.93	4.04	4.02	3.43	3.42	4.06

Table 3.6.3
Key Component Blends and Synergistic Effects
Theoretical MAT Data

	BLEND A			BLEND B			BLEND C		
	60	120	200	60	120	200	60	120	200
Components									
Hydrogen	0.06	0.06	0.09	0.02	0.04	0.06	0.04	0.06	0.09
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	2.34	2.28	2.37	0.09	0.08	0.07	0.14	0.14	0.11
Carbon Dioxide	0.27	0.27	0.28	0.24	0.25	0.25	0.23	0.26	0.27
Methane	0.36	0.36	0.46	0.23	0.31	0.37	0.24	0.31	0.36
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylane	0.30	0.12	0.19	0.27	0.39	0.47	0.29	0.41	0.47
Ethane	0.45	0.54	0.56	0.25	0.32	0.37	0.27	0.36	0.43
Propyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	6.20	6.24	7.08	6.01	5.50	5.74	5.22	5.00	5.22
Propane	1.60	1.67	1.93	1.50	2.14	2.54	1.74	2.43	2.74
1,3-Butadiene	0.06	0.02	0.02	0.04	0.04	0.03	0.04	0.04	0.03
Butenes	6.00	6.32	6.72	4.64	3.90	3.89	3.88	3.38	3.43
n-Butane	2.87	2.57	3.23	2.85	3.12	3.44	2.81	3.28	3.58
i-Butane	7.11	7.76	8.67	12.08	12.07	13.30	9.56	10.04	10.89
C5 Cyclos+Olefins	2.07	2.06	1.76	1.87	1.51	1.39	1.65	1.79	1.58
n-Pentane	2.14	1.97	2.77	1.71	1.67	1.84	1.57	1.65	1.73
i-Pentane	9.17	9.54	10.44	7.57	7.54	8.50	6.78	6.89	7.45
Thiophene	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	0.91	1.13	1.00	1.40	1.69	1.49	1.99	2.45	2.15
C6 Cyclos+Olefins	2.01	1.82	1.32	2.11	1.64	1.55	1.75	1.77	2.04
Hexanes	5.83	6.46	6.03	4.26	4.90	5.25	4.16	4.59	4.55
Toluene	0.96	1.04	1.30	1.36	1.56	1.59	1.48	1.78	1.74
C7 Cyclos+Olefins	1.70	1.81	0.82	2.39	2.47	2.11	2.65	2.32	2.03
Heptanes	5.05	5.96	3.86	5.10	5.31	5.08	4.95	5.29	4.93
C8 alkylBenzenes	3.92	4.12	4.45	3.12	4.32	4.89	4.10	5.06	5.47
C8 cycloOlefins	1.48	1.09	0.76	1.68	1.65	1.02	1.52	1.69	1.12
Octanes	6.83	7.90	7.09	4.77	4.32	4.29	4.40	4.41	3.97
C9 Aromatics	3.23	4.83	4.52	5.04	6.61	6.12	6.78	7.03	7.23
C9 Cyclos+Olefins	0.18	0.01	0.01	0.60	0.37	0.20	0.53	0.32	0.16
Nonanes	2.47	3.01	3.03	3.81	3.04	2.26	2.95	2.15	2.03
C10 Aromatics	5.52	4.85	4.99	6.96	7.27	6.53	9.58	8.35	8.24
C10 Olefins	0.00	0.00	0.00	0.25	0.10	0.05	0.30	0.09	0.04
C10 Paraffins	1.70	0.89	1.12	2.05	1.50	1.54	0.83	0.43	0.64
C11 Aromatics	2.66	2.54	2.70	3.93	4.07	3.46	5.51	5.28	4.54
C11 Olefins	0.00	0.00	0.00	0.05	0.02	0.00	0.07	0.00	0.00
C11 Paraffins	0.58	0.35	0.65	1.13	0.81	0.76	0.33	0.18	0.40
C12 Aromatics	1.47	1.52	1.93	2.22	2.65	2.54	3.06	3.50	2.92
C12 Olefins	0.00	0.00	0.00	0.00	0.10	0.03	0.00	0.08	0.03
C12 Paraffins	0.55	0.50	0.56	1.14	0.67	0.40	0.38	0.46	0.31
C13 Aromatics	1.14	0.82	1.18	1.19	1.45	1.51	1.42	1.69	1.61
C13 Olefins	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	0.31	0.20	0.16	0.45	0.18	0.14	0.00	0.00	0.00
C14 Aromatics	0.84	0.75	0.61	1.05	0.89	0.87	1.41	1.24	1.03
C14 Olefins	0.25	0.10	0.00	0.03	0.00	0.02	0.03	0.00	0.01
C14 Paraffins	1.17	0.56	0.38	0.39	0.07	0.06	0.00	0.00	0.00
C15 Aromatics	0.49	0.26	0.20	0.78	0.42	0.40	0.99	0.55	0.42
C15 Olefins	0.20	0.05	0.00	0.69	0.00	0.00	0.57	0.00	0.00
C15 Paraffins	0.91	0.50	0.10	0.00	0.00	0.04	0.00	0.00	0.07
C16 Aromatics	0.30	0.11	0.21	0.49	0.18	0.33	0.56	0.17	0.37
C16 Olefins	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	0.68	0.33	0.13	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	0.39	0.15	0.18	0.36	0.19	0.17	0.57	0.12	0.18
C17 Paraffins	0.24	0.18	0.13	0.00	0.00	0.00	0.00	0.00	0.00
C18+	1.79	1.16	0.49	0.07	0.02	0.06	0.26	0.08	0.14
COKE	2.96	3.26	3.58	2.11	2.63	2.97	2.32	2.90	3.23

Table 3.6.4
Key Component Blends and Synergistic Effects
Experimental and Theoretical MAT Yields

	EXPERIMENTAL									THEORETICAL								
	BLEND A			BLEND B			BLEND C			BLEND A			BLEND B			BLEND C		
Contact Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
Analytical Yields																		
Hydrogen	0.15	0.18	0.24	0.08	0.15	0.13	0.13	0.05	0.10	0.06	0.06	0.09	0.02	0.04	0.06	0.04	0.06	0.09
H2-C2	2.67	3.18	3.46	1.98	2.06	1.67	1.08	1.13	1.68	3.51	3.36	3.68	0.86	1.14	1.34	0.98	1.28	1.46
C3C4	23.27	24.26	25.28	31.13	32.88	31.30	23.54	24.44	26.03	23.85	24.59	27.66	27.12	26.77	28.94	23.25	24.17	25.89
C5's	10.70	11.52	12.55	12.60	13.03	13.01	8.37	10.68	11.13	13.42	13.62	15.00	11.15	10.72	11.73	10.01	10.33	10.76
C5+ Gasoline	49.68	52.90	51.74	53.75	50.11	53.24	53.75	54.11	51.78	58.45	61.43	58.65	61.19	62.40	59.91	63.88	63.51	62.03
C6+ Gasoline	38.99	41.38	39.19	41.14	37.08	40.23	45.38	43.44	40.65	45.03	47.81	43.64	50.04	51.68	48.18	53.88	53.18	51.27
LCO+DO	20.00	14.71	13.42	8.94	10.67	9.48	18.01	16.73	16.24	10.98	7.23	6.23	8.85	6.82	6.57	9.26	7.88	7.09
COKE	3.97	4.55	5.58	3.93	4.04	4.02	3.43	3.42	4.06	2.98	3.26	3.58	2.11	2.63	2.97	2.32	2.90	3.23
Conversion	80.00	85.29	86.58	91.06	89.33	90.52	81.99	83.27	83.76	89.02	92.77	93.77	91.15	93.18	93.43	90.74	92.12	92.91

Table 3.7.1
The Effects of Residual Catalyst Coke on Cracking Yields
Blend A

Carbon on Catalyst	%	0.11			0.27			0.48		
Contact Time	(s)	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	2.36	2.84	3.78	2.69	2.85	3.53	3.51	4.32	3.50
C3C4	:	21.44	24.13	26.67	23.62	21.82	25.98	21.31	24.09	23.39
C5'S	:	11.71	12.94	13.50	10.92	10.29	12.36	9.97	10.12	12.30
C5 + Gasoline	:	57.56	56.34	53.32	54.97	57.00	53.35	53.57	52.12	53.94
C6 + Gasoline	:	45.85	43.40	39.82	44.05	46.71	40.98	43.59	42.00	41.64
Light Cycle Oil	:	11.55	9.27	8.12	11.58	11.03	8.74	13.98	11.41	10.20
Decant Oil	:	3.02	2.81	2.27	3.13	3.19	2.54	3.35	3.16	3.04
Coke	:	4.08	4.62	5.83	4.01	4.12	5.86	4.29	4.91	5.94
Conversion	:	85.43	87.92	89.61	85.29	85.78	88.72	82.67	85.43	86.76
COMPOSITIONAL YIELDS - mass %FF										
COMPONENTS										
Hydrogen	:	0.14	0.17	0.24	0.14	0.15	0.24	0.13	0.21	0.22
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	1.33	1.04	1.35	1.38	1.13	1.53	2.48	2.53	2.09
Carbon Dioxide	:	0.47	0.48	0.56	0.50	0.53	0.60	0.41	0.49	0.43
Methane	:	0.23	0.39	0.55	0.28	0.34	0.49	0.21	0.36	0.32
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.18	0.43	0.59	0.29	0.45	0.42	0.20	0.42	0.25
Ethane	:	0.44	0.78	1.00	0.56	0.73	0.81	0.44	0.75	0.59
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	5.98	7.09	7.62	6.84	6.52	7.43	6.29	7.32	6.80
Propane	:	1.08	1.36	1.94	1.22	1.21	1.64	0.97	1.32	1.23
1,3-Butadiene	:	0.06	0.08	0.10	0.07	0.08	0.08	0.06	0.08	0.06
Butenes	:	5.75	6.68	6.38	6.80	6.32	6.74	6.70	7.14	6.82
n-Butane	:	2.42	2.61	3.11	2.35	2.27	2.94	1.99	2.28	2.36
i-Butane	:	6.00	6.18	7.20	6.03	5.23	6.81	5.08	5.56	5.89
cycloPentene	:	0.02	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Pentenes	:	3.41	3.45	3.20	2.79	3.73	2.77	3.15	3.07	3.57
n-Pentane	:	2.28	2.39	2.85	2.04	3.46	2.42	1.75	1.88	2.18
i-Pentane	:	8.82	8.56	9.43	6.99	10.85	8.24	6.07	6.31	7.73
Thiophene	:	0.06	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	0.57	0.48	0.67	0.36	0.39	0.49	0.38	0.18	0.42
C6 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	2.85	3.83	5.17	2.53	4.31	2.20	2.72	2.89	3.15
Hexanes	:	7.73	6.45	8.36	4.64	4.99	5.07	4.65	4.11	5.01
Toluene	:	0.47	0.54	0.62	0.44	1.02	0.82	0.46	0.63	0.64
C7 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	:	2.31	2.22	2.31	1.06	2.04	1.54	1.11	1.61	1.23
Heptanes	:	7.05	6.22	4.11	5.21	5.92	4.85	5.31	5.01	5.14
C8 alkylBenzenes	:	1.30	1.19	1.62	0.94	2.95	1.90	0.98	0.86	0.89
C8 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	2.54	1.51	1.90	1.56	2.20	1.44	1.63	1.43	1.44
Octanes	:	12.12	9.25	8.99	8.19	8.26	6.38	8.52	7.57	6.72
Indenes	:	0.12	0.38	0.29	0.63	0.48	0.26	0.85	0.40	0.32
C9 alkylBenzenes	:	0.83	1.35	1.28	1.31	2.20	1.49	1.37	1.49	1.28
C9 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.00	0.38	0.38	0.25	0.75	0.36	0.26	0.46	0.32
Nonanes	:	5.50	4.49	3.52	2.38	3.54	2.47	2.47	2.75	2.56
C10 Aromatics	:	1.24	1.89	1.28	3.38	2.79	2.93	3.51	5.39	5.50
C10 Olefins	:	0.00	0.54	0.33	0.63	1.02	0.57	0.65	0.46	0.53
C10 Paraffins	:	3.61	2.80	1.95	1.75	1.93	1.08	1.82	1.38	1.17
C11 Aromatics	:	0.59	0.92	1.05	3.32	1.34	3.03	3.45	0.86	0.43
C11 Olefins	:	0.00	0.54	0.29	0.81	0.86	0.51	0.85	0.80	0.53
C11 Paraffins	:	2.01	1.51	0.95	1.25	1.02	0.82	1.30	0.06	1.07
C12 Aromatics	:	0.65	0.49	0.52	2.38	0.70	2.42	2.47	2.64	2.56
C12 Olefins	:	0.53	0.54	0.10	0.56	0.32	0.15	0.59	0.52	0.43
C12 Paraffins	:	0.89	0.97	0.86	1.00	0.70	0.46	1.04	0.86	0.69
C13 Aromatics	:	0.53	0.81	0.19	2.50	0.38	1.80	2.60	2.35	2.29
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.71	0.92	0.38	0.13	0.54	0.31	0.13	0.57	0.48
C14 Aromatics	:	0.35	0.65	0.24	2.63	0.32	1.34	2.73	2.06	2.72
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.41	0.49	0.05	0.25	0.00	0.26	0.28	-0.34	0.18
C15 Aromatics	:	0.24	0.49	0.14	1.75	0.21	1.65	1.82	1.15	1.39
C15 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00
C15 Paraffins	:	0.12	0.32	0.00	0.31	0.00	0.21	0.33	0.40	0.00
C16 Aromatics	:	0.18	0.38	0.05	1.25	0.54	1.08	1.30	0.97	1.01
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.18	0.16	0.00	0.06	0.00	0.00	0.07	0.00	0.00
C17 Aromatics	:	0.24	0.16	0.00	1.50	0.16	1.08	1.58	1.43	1.23
C17 Paraffins	:	0.12	0.11	0.05	0.00	0.00	0.15	0.00	0.00	0.00
C18+	:	1.24	0.02	0.38	2.69	1.02	1.80	2.80	3.50	2.19

Table 3.7.1 (con't)
The Effects of Residual Catalyst Coke on Cracking Yields
Blend B

Carbon on Catalyst	%	0.11			0.27			0.48		
Contact Time	(s)	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	0.55	0.57	0.95	0.35	0.57	0.88	0.46	0.65	1.02
C3C4	:	23.33	22.89	24.93	20.83	24.98	25.01	22.65	23.59	27.36
C5'S	:	9.18	11.27	10.05	9.08	11.19	10.48	10.18	10.74	14.56
C5 + Gasoline	:	59.42	59.59	57.25	58.54	56.70	57.13	52.06	53.63	54.62
C6 + Gasoline	:	50.24	48.32	47.20	49.46	45.50	46.64	41.88	42.90	40.06
Light Cycle Oil	:	12.77	12.57	11.59	15.45	12.93	11.42	19.94	16.88	10.83
Decant Oil	:	1.82	1.86	2.15	2.25	1.99	1.97	2.19	2.17	1.53
Coke	:	2.12	2.52	3.13	2.58	2.83	3.60	2.71	3.07	4.54
Conversion	:	85.41	85.57	86.26	82.30	85.08	86.61	77.87	80.95	87.54
COMPOSITIONAL YIELDS - mass %FF										
COMPONENTS										
Hydrogen	:	0.02	0.03	0.07	0.02	0.03	0.06	0.02	0.03	0.06
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	:	0.14	0.17	0.19	0.15	0.19	0.20	0.19	0.20	0.21
Methane	:	0.17	0.18	0.28	0.11	0.19	0.27	0.17	0.22	0.40
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.13	0.11	0.25	0.05	0.10	0.19	0.06	0.11	0.14
Ethane	:	0.22	0.24	0.35	0.18	0.26	0.35	0.21	0.29	0.41
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	5.44	5.27	5.24	4.74	5.84	5.57	5.75	5.79	7.16
Propane	:	1.02	1.11	1.69	0.81	1.13	1.43	0.77	1.07	1.47
1,3-Butadiene	:	0.03	0.07	0.04	0.06	0.04	0.03	0.04	0.06	0.09
Butenes	:	4.25	3.62	3.50	3.79	4.42	3.86	5.18	4.68	5.41
n-Butane	:	2.23	2.60	2.88	2.08	2.61	2.62	2.06	2.32	2.89
i-Butane	:	10.56	10.12	11.71	9.39	10.83	11.36	8.74	9.56	10.39
cycloPentene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00
Pentenes	:	2.45	1.53	2.15	1.08	1.13	0.93	2.18	1.87	1.83
n-Pentane	:	2.03	2.33	2.10	1.77	2.03	2.10	1.65	2.15	2.89
i-Pentane	:	8.59	10.38	9.73	7.92	8.98	9.51	7.62	8.69	11.43
Thiophene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	1.49	1.30	0.90	1.13	1.82	1.52	2.14	1.41	1.48
C6 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	2.97	2.45	3.13	1.62	1.48	2.75	2.82	2.77	2.62
Hexanes	:	2.11	9.15	9.56	5.81	5.33	9.31	5.21	6.43	9.52
Toluene	:	0.89	0.83	0.69	0.47	0.94	0.64	0.78	1.22	0.61
C7 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.06	0.20	0.13	0.05
Heptenes	:	4.15	3.88	3.03	2.28	2.51	3.83	3.00	3.27	3.50
Heptanes	:	10.06	9.88	9.28	6.20	5.86	9.23	4.14	5.88	8.10
C8 alkylBenzenes	:	2.15	2.33	2.40	1.06	2.40	1.60	1.89	3.35	1.26
C8 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	2.82	2.43	3.28	1.80	1.99	2.62	2.02	1.60	2.07
Octanes	:	9.12	7.58	6.31	4.80	4.44	7.40	3.59	5.65	5.85
Indenes	:	0.30	0.53	0.32	0.53	0.47	0.28	1.11	1.15	0.20
C9 alkylBenzenes	:	1.70	1.83	2.27	1.60	1.40	1.34	2.74	3.53	1.06
C9 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.74	0.24	0.32	0.27	0.12	0.38	0.78	0.13	0.30
Nonanes	:	6.22	4.58	3.28	3.40	2.75	4.80	3.78	3.40	3.63
C10 Aromatics	:	2.89	2.43	2.97	3.27	4.79	2.11	4.63	4.94	1.66
C10 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
C10 Paraffins	:	3.71	2.66	2.90	2.20	1.93	2.49	2.28	1.80	1.97
C11 Aromatics	:	0.67	0.24	0.44	6.21	4.85	1.34	4.30	3.21	1.06
C11 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
C11 Paraffins	:	1.85	1.24	0.76	2.47	0.76	1.02	1.69	1.80	0.81
C12 Aromatics	:	0.82	0.53	0.82	3.27	3.04	0.64	1.63	1.60	0.50
C12 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	:	1.04	0.77	0.76	1.73	0.94	0.13	1.30	0.71	0.10
C13 Aromatics	:	0.44	0.24	0.44	2.80	2.16	0.45	1.37	1.03	0.35
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.07	0.12	0.06	0.67	0.35	0.13	0.13	0.00	0.10
C14 Aromatics	:	0.37	0.30	0.25	2.87	1.70	0.51	1.50	0.83	0.40
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.00	0.00	0.00	0.27	0.18	0.00	0.00	0.00	0.00
C15 Aromatics	:	0.30	0.18	0.19	2.40	1.99	0.38	0.39	0.38	0.30
C15 Olefins	:	2.96	2.72	1.51	2.14	1.87	1.60	4.89	0.37	1.26
C15 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	:	0.22	0.12	0.13	2.14	1.64	0.38	0.72	0.32	0.30
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.00
C17 Aromatics	:	0.22	0.12	0.13	0.80	0.47	0.13	0.33	0.13	0.10
C17 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	:	0.30	1.07	0.57	1.47	1.23	0.89	2.87	2.95	1.50

Table 3.7.1 (con't)
The Effects of Residual Catalyst Coke on Cracking Yields
Blend C

Carbon on Catalyst	%	0.11			0.27			0.48		
Contact Time	(s)	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	0.46	0.68	1.05	0.59	1.30	0.98	0.50	0.70	0.88
C3C4	:	18.06	21.84	19.43	22.01	26.81	25.11	17.97	21.42	22.03
C5'S	:	7.49	12.00	8.27	11.06	13.25	10.20	9.69	10.04	9.25
C5 + Gasoline	:	59.09	55.72	56.39	55.87	52.01	54.30	52.15	49.90	50.23
C6 + Gasoline	:	51.60	43.72	48.12	44.82	38.76	44.10	42.46	39.86	40.98
Light Cycle Oil	:	17.79	16.05	16.76	16.91	14.43	13.32	24.39	20.97	19.28
Decant Oil	:	2.38	2.21	2.48	2.20	1.96	2.34	2.31	4.48	4.51
Coke	:	2.22	3.49	3.89	2.42	3.49	3.95	2.68	2.54	3.07
Conversion	:	79.83	81.74	80.76	80.89	83.61	84.34	73.30	74.55	76.21
COMPOSITIONAL YIELDS - mass %FF										
COMPONENTS										
Hydrogen	:	0.02	0.04	0.09	0.03	0.09	0.07	0.02	0.04	0.06
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	:	0.14	0.19	0.16	0.18	0.22	0.21	0.18	0.19	0.20
Methane	:	0.12	0.23	0.34	0.18	0.44	0.29	0.16	0.19	0.24
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.14	0.10	0.24	0.11	0.26	0.25	0.09	0.17	0.24
Ethane	:	0.18	0.31	0.38	0.26	0.50	0.37	0.23	0.30	0.33
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	4.05	5.41	4.62	5.47	7.62	5.71	4.77	4.79	4.68
Propane	:	1.01	1.22	1.43	1.11	1.45	1.74	0.74	1.33	1.63
1,3-Butadiene	:	0.05	0.06	0.03	0.07	0.09	0.04	0.02	0.07	0.03
Butenes	:	3.04	3.88	3.08	3.99	5.31	3.98	4.07	3.33	2.94
n-Butane	:	2.31	2.80	2.51	2.74	3.15	3.26	1.97	2.85	3.14
i-Butane	:	7.87	8.35	7.72	8.53	9.05	10.24	6.29	9.05	9.60
cycloPentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	:	1.55	1.02	0.92	0.90	1.59	1.02	1.52	1.45	0.79
n-Pentane	:	1.82	2.31	1.69	2.15	2.78	2.60	1.94	2.23	1.94
i-Pentane	:	7.66	9.33	7.02	8.80	9.28	8.36	7.12	8.89	8.06
Thiophene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	2.54	2.30	2.27	0.66	1.35	1.98	1.36	2.35	2.16
C6 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	2.65	1.78	1.62	1.11	1.01	1.79	2.59	2.68	1.89
Hexanes	:	8.35	6.68	5.50	4.53	4.95	5.19	6.01	7.94	6.44
Toluene	:	1.29	0.89	1.47	0.45	0.31	1.65	0.81	1.48	1.79
C7 cycloOlefins	:	0.00	0.12	0.00	0.13	0.00	0.00	0.15	0.06	0.00
Heptenes	:	4.52	3.19	2.94	2.81	1.89	2.18	3.02	4.04	3.32
Heptanes	:	9.16	7.27	5.80	5.60	4.32	5.53	7.49	8.82	7.00
C8 alkylBenzenes	:	2.29	1.28	2.34	0.71	2.58	2.96	1.47	2.71	3.32
C8 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	3.29	2.72	2.47	2.20	1.97	1.77	2.65	2.32	2.39
Octanes	:	8.43	6.02	5.08	4.53	2.84	4.30	6.27	7.35	6.11
Indenes	:	0.93	0.53	0.67	0.71	1.30	0.47	0.59	0.77	0.73
C9 alkylBenzenes	:	1.86	1.71	2.21	1.42	3.11	1.94	1.55	1.81	2.12
C9 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.43	1.00	1.67	0.84	0.47	0.24	0.66	0.52	0.46
Nonanes	:	5.36	3.19	2.68	3.04	1.81	2.53	2.80	4.77	2.85
C10 Aromatics	:	4.86	5.02	4.55	5.82	5.60	3.30	5.16	3.80	5.58
C10 Olefins	:	0.57	0.24	0.27	0.13	0.16	0.00	0.22	0.13	0.20
C10 Paraffins	:	1.86	0.83	0.94	0.00	0.00	0.00	0.96	2.26	1.06
C11 Aromatics	:	2.64	5.49	5.48	6.47	5.39	4.24	5.09	2.19	3.45
C11 Olefins	:	0.14	0.24	0.40	0.32	0.16	0.12	0.15	0.00	0.20
C11 Paraffins	:	1.07	0.41	0.60	0.97	0.47	1.18	0.74	1.68	0.53
C12 Aromatics	:	1.29	3.25	3.48	3.75	3.84	3.94	2.73	0.90	3.92
C12 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	:	0.57	0.85	0.87	1.10	0.41	1.00	0.52	0.13	0.20
C13 Aromatics	:	0.50	1.42	2.74	2.91	2.44	2.00	1.70	0.45	1.33
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.14	0.00	0.00	0.19	0.05	0.24	0.07	0.19	0.20
C14 Aromatics	:	0.29	1.12	3.01	4.46	1.81	2.65	2.21	0.26	0.86
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	:	0.07	0.71	1.94	2.33	1.35	1.77	1.40	0.13	1.19
C15 Olefins	:	2.36	2.13	2.07	2.46	1.09	0.88	3.98	2.32	1.46
C15 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	:	0.07	0.35	1.00	1.42	0.93	1.29	1.47	0.06	0.53
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	:	0.07	0.18	0.67	1.29	0.93	1.18	1.55	0.00	0.20
C17 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	:	0.29	0.53	1.34	1.10	2.33	2.24	2.80	0.64	1.73

Table 3.8.1
Thermal and Hydrothermal Deactivation of Cracking Catalyst
* DA-440 *

Sample Number	Temperature deg C	Hydrothermal Deactivation Period hrs	Thermal Deactivation Period hrs
XC017DS	732	4	
XC019DS	732	8	
XC016DS	732	16	
XC018DS	732	32	
XC033DT	899		8
XC034DT	899		16
XC035DT	899		32
XC036DT	860		1
XC037DT	860		2
XC038DT	860		4
XC039DT	860		8
XC040DT	860		16

Catalyst steaming was performed in an atmosphere of 100% steam at 5 psi.

Table 3.8.2
Hydrothermal Deactivation of Cracking Catalyst
Blend A

Catalyst Deactivation		Steamed 8hrs			Steamed 16hrs			Steamed 32hrs			Thermal 4hrs			Thermal 8hrs			Thermal 16hrs		
Contact Time	(s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF																			
PRODUCTS																			
H2 - C2	:	4.01	4.75	4.21	3.85	4.06	4.05	3.29	4.07	4.57	3.66	4.36	5.35	3.79	3.67	4.30	4.16	4.12	5.25
C3C4	:	29.99	33.63	29.26	27.48	26.47	28.06	25.13	27.57	33.83	29.69	32.54	35.78	27.89	27.34	28.83	30.75	32.27	36.17
C5'S	:	11.82	15.06	12.60	10.13	10.82	11.94	9.65	10.12	14.05	12.41	12.72	15.26	10.48	11.42	9.76	10.75	15.09	14.73
C5 + Gasoline	:	48.01	46.23	48.14	52.46	52.29	50.60	54.43	52.58	46.16	48.92	44.65	38.44	51.24	48.08	47.17	45.53	45.90	40.58
C6 + Gasoline	:	36.20	31.17	35.54	42.33	41.46	38.66	44.78	42.45	32.13	36.51	31.93	23.18	40.77	36.67	37.42	34.78	30.81	25.85
Light Cycle Oil	:	8.77	5.16	6.74	8.16	6.25	6.80	8.52	7.30	5.89	6.49	4.71	4.42	7.46	7.05	6.56	6.51	4.74	4.27
Decant Oil	:	2.11	1.20	1.73	1.65	1.25	1.33	2.11	1.26	1.13	1.07	0.63	0.71	1.31	1.71	1.49	1.41	0.61	0.83
Coke	:	7.11	9.02	9.92	6.40	7.69	9.15	6.42	7.22	8.30	10.17	13.11	11.33	8.30	11.44	11.64	11.64	12.35	12.71
Conversion	:	89.12	93.64	91.53	90.19	92.50	91.87	89.27	91.44	92.98	92.44	94.66	94.87	91.23	91.24	91.95	92.08	94.65	94.90
COMPOSITIONAL YIELDS - mass %FF																			
COMPONENTS																			
Hydrogen	:	0.09	0.10	0.12	0.06	0.07	0.08	0.08	0.08	0.13	0.08	0.14	0.15	0.07	0.09	0.10	0.16	0.12	0.19
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	2.15	2.30	1.96	2.21	2.12	2.09	1.88	2.10	2.34	1.79	1.73	2.03	1.93	1.80	2.02	1.85	1.89	2.27
Carbon Dioxide	:	0.48	0.54	0.46	0.48	0.58	0.52	0.46	0.51	0.64	0.48	0.51	0.73	0.46	0.46	0.48	0.49	0.54	0.58
Methane	:	0.57	0.75	0.70	0.49	0.55	0.57	0.40	0.56	0.71	0.55	0.82	1.02	0.55	0.82	0.70	0.88	0.88	0.97
Acetylene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	:	0.49	0.64	0.53	0.43	0.48	0.48	0.34	0.48	0.54	0.54	0.68	0.87	0.51	0.52	0.58	0.58	0.52	0.74
Ethane	:	0.66	0.91	0.86	0.62	0.77	0.80	0.57	0.79	0.91	0.66	0.96	1.23	0.69	0.80	0.86	0.82	0.87	1.13
Propyne	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	:	6.13	6.12	5.23	6.01	5.78	5.25	5.73	5.94	6.54	4.72	4.78	4.28	5.39	4.57	4.57	4.35	4.81	5.05
Propane	:	3.23	4.36	3.95	2.70	3.27	3.49	2.26	2.99	3.92	4.37	5.37	8.08	3.40	3.87	4.80	5.07	4.72	5.98
1,3-Butadiene	:	0.02	0.02	0.00	0.04	0.02	0.00	0.03	0.03	0.01	0.00	0.00	0.00	0.02	0.01	0.02	0.00	0.00	0.00
Butenes	:	3.98	3.64	3.06	4.24	3.62	3.16	4.16	3.87	3.72	2.73	2.37	2.00	3.29	2.61	2.49	2.31	2.54	2.40
n-Butane	:	4.79	5.95	5.23	4.01	4.63	4.88	3.58	4.17	5.79	5.84	6.46	8.29	4.86	5.31	5.33	5.93	6.67	7.27
i-Butane	:	11.55	13.23	11.53	10.27	10.93	11.06	9.19	10.39	13.53	12.01	13.30	16.71	10.92	11.17	11.62	12.96	13.27	15.17
cycloPentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	:	0.68	0.73	0.59	1.05	0.93	0.82	0.84	0.85	0.73	0.88	0.72	0.77	0.68	0.58	0.69	0.60	0.67	0.73
n-Pentane	:	2.10	2.86	2.30	2.01	2.09	2.19	1.92	1.92	2.54	2.38	2.56	3.15	2.04	2.29	2.01	2.04	2.95	2.68
i-Pentane	:	9.88	12.04	10.25	8.68	9.30	10.10	8.32	8.70	11.54	10.58	10.64	12.40	8.96	9.67	8.51	9.11	12.26	12.14
Thiophene	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	:	0.46	0.38	0.43	0.46	0.44	0.47	0.48	0.45	0.40	0.70	0.63	0.46	0.53	0.55	0.49	0.41	0.44	0.33
C6 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	:	1.07	0.74	6.02	1.28	0.97	0.91	1.25	0.98	0.81	0.89	1.02	0.66	0.81	1.00	0.85	0.61	0.86	0.72
Hexanes	:	5.13	4.80	5.01	5.21	5.18	5.65	5.31	5.05	4.92	5.11	4.75	4.07	4.78	4.94	4.81	4.31	5.10	4.29
Toluene	:	1.14	0.81	1.13	1.05	0.91	1.17	1.02	0.91	0.92	0.95	0.89	0.68	1.07	1.11	1.16	1.03	1.02	0.86
C7 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	:	1.33	0.95	0.95	1.57	1.35	1.21	1.41	1.21	0.82	0.83	0.89	0.67	0.97	1.15	1.25	0.78	0.84	0.75
Heptanes	:	4.84	3.57	3.90	5.36	4.74	5.00	5.39	4.73	4.19	4.28	3.80	2.79	4.81	4.22	4.18	4.33	3.64	3.07
C8 alkylBenzenes	:	3.06	2.25	2.84	2.87	2.80	3.05	2.78	2.51	2.27	2.48	2.38	1.73	2.53	2.51	2.77	2.34	2.11	1.82
C8 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	:	1.40	0.88	1.10	1.52	1.15	1.35	1.55	1.16	1.04	1.06	0.68	0.49	1.22	0.84	0.85	1.16	0.74	0.51
Octanes	:	7.02	4.26	4.85	7.94	5.87	5.92	8.45	6.14	4.74	4.84	3.90	3.12	5.98	5.05	5.58	5.11	3.79	3.51
Indenes	:	0.42	0.21	0.24	0.63	0.38	0.40	0.58	0.35	0.29	0.40	0.18	0.13	0.53	0.27	0.27	0.46	0.20	0.17
C9 alkylBenzenes	:	2.54	2.04	2.32	2.82	2.74	2.83	2.81	2.72	2.17	2.87	2.18	1.77	2.87	2.35	2.68	2.69	1.98	1.88
C9 cycloOlefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonanes	:	3.10	1.79	2.00	3.81	2.55	2.98	3.84	2.87	2.12	1.92	1.50	1.08	2.48	2.08	2.05	2.17	1.64	1.32
C10 Aromatics	:	3.71	2.78	3.08	4.13	3.75	3.77	4.33	3.82	3.06	3.37	2.72	1.95	3.94	3.41	3.39	2.76	2.15	1.77
C10 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	:	1.40	0.84	1.21	1.62	1.20	1.53	1.84	1.41	1.42	0.79	0.75	0.48	0.92	0.93	0.85	0.78	0.70	0.53
C11 Aromatics	:	2.93	2.53	2.47	3.14	3.27	2.87	3.35	3.32	2.22	2.85	2.18	1.70	3.31	2.97	3.21	3.14	2.35	2.49
C11 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	:	0.66	0.49	0.43	1.31	1.15	0.90	1.15	1.01	0.81	0.78	0.43	0.52	0.68	0.40	0.57	0.56	0.30	0.42
C12 Aromatics	:	1.22	2.18	1.25	1.38	2.89	1.53	1.43	2.87	1.19	2.86	2.47	1.73	3.18	2.92	2.81	2.86	2.25	1.83
C12 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	:	0.23	0.14	0.11	0.25	0.19	0.13	0.27	0.20	0.11	0.06	0.07	0.05	0.10	0.13	0.13	0.08	0.10	0.08
C13 Aromatics	:	0.67	1.55	0.86	0.88	1.54	0.76	0.90	1.96	0.79	1.88	1.47	0.98	2.19	1.82	1.74	2.06	1.54	1.26
C13 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	:	0.42	0.11	0.00	0.16	0.05	0.00	0.18	0.05	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.03	0.00
C14 Aromatics	:	0.48	0.84	0.72	0.98	1.83	1.39	1.02	1.98	1.14	1.44	0.83	0.82	1.65	1.11	1.38	1.34	0.90	0.84
C14 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	:	0.82	1.27	0.84	0.78	1.54	0.94	0.72	1.46	0.70	1.15	0.97	0.54	1.90	1.88	1.34	1.38	1.11	0.71
C15 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	:	0.77	0.63	0.59	0.42	0.53	0.40	1.02	0.88	0.62	0.41	0.54	0.21	0.87	1.33	0.63	0.68	0.87	0.35
C16 Olefins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	:	1.24	0.56	0.85	0.68	0.34	0.49	2.59	1.08	1.43	0.56	0.54	0.28	0.87	0.84	0.63	0.59	0.50	0.31
C17 Paraffins	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	:	0.24	0.14	0.22	0.47	0.00	0.13	0.20	0.45	0.18	0.12	0.11	0.05	0.15	0.18	0.09	0.08	0.07	0.04

Table 3.8.2 (con't)
Hydrothermal Deactivation of Cracking Catalyst
Blend 9

Catalyst Deactivation	Steamed 8hrs			Steamed 16hrs			Steamed 32hrs			Thermal 4hrs			Thermal 8hrs			Thermal 16hrs		
Contact Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF																		
PRODUCTS																		
H2 - C2	0.96	1.32	1.25	1.00	1.39	1.25	0.92	1.38	1.51	1.59	2.57	2.49	1.77	2.00	2.31	1.74	2.23	[illegible]
C3C4	27.19	29.42	27.74	24.37	27.60	29.36	29.82	29.23	30.01	32.18	33.80	34.59	29.69	32.43	33.92	31.13	33.79	33.59
C5'S	14.87	13.02	15.00	13.44	12.48	14.34	14.24	13.52	14.20	14.52	17.54	13.54	7.74	11.90	13.18	13.12	12.65	[illegible]
C5 + Gasoline	57.01	55.01	55.37	57.85	56.30	54.04	56.55	55.90	54.02	50.25	41.53	45.59	52.59	49.27	46.97	50.78	49.12	45.52
C6 + Gasoline	42.13	41.99	40.37	44.41	43.82	39.71	42.32	42.17	39.82	35.73	23.99	32.06	44.84	37.37	33.79	37.65	35.45	[illegible]
Light Cycle Oil	8.30	9.24	8.07	8.00	7.71	7.54	9.12	7.15	7.63	6.22	5.37	5.92	6.65	7.47	5.89	7.03	5.40	6.37
Decant Oil	1.14	1.16	1.14	1.25	1.24	1.14	0.99	1.15	1.14	0.66	0.60	0.68	0.69	1.07	0.59	0.77	0.57	0.71
Coke	5.40	5.87	6.43	4.53	5.76	6.41	3.90	5.32	5.69	9.10	10.13	10.74	8.63	7.76	10.43	8.56	9.90	11.25
Conversion	90.56	90.60	90.79	90.75	91.05	91.32	89.89	91.70	91.23	93.12	94.03	93.40	92.86	91.46	93.52	92.20	94.03	92.92
COMPOSITIONAL YIELDS - mass %FF																		
COMPONENTS																		
Hydrogen	0.02	0.06	0.05	0.03	0.05	0.06	0.02	0.06	0.07	0.05	0.09	0.10	0.04	0.06	0.08	0.05	0.08	0.09
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.23	0.27	0.26	0.21	0.24	0.24	0.25	0.26	0.28	0.40	0.44	0.34	0.24	0.27	0.37	0.29	0.31	0.32
Methane	0.29	0.39	0.40	0.29	0.42	0.48	0.27	0.42	0.46	0.45	0.75	0.76	0.47	0.57	0.70	0.46	0.84	0.55
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	0.27	0.39	0.32	0.30	0.44	0.42	0.25	0.41	0.42	0.58	0.88	0.80	0.86	0.71	0.74	0.80	0.81	0.82
Ethane	0.37	0.47	0.48	0.38	0.47	0.55	0.38	0.47	0.54	0.50	0.83	0.81	0.59	0.84	0.78	0.51	0.69	0.77
Propyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	5.23	3.94	4.58	5.34	4.75	4.92	5.87	5.38	5.29	4.43	4.17	3.80	4.12	4.72	3.44	4.68	4.07	3.46
Propane	2.18	3.40	2.84	2.10	2.78	3.15	1.90	2.50	2.97	4.09	7.18	6.01	4.73	4.36	6.24	3.80	5.52	5.24
1,3-Butadiene	0.02	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.03	0.01	0.00	0.00	0.00
Butenes	2.93	2.01	2.80	3.18	2.52	2.81	3.76	2.88	2.82	1.98	1.36	1.34	1.57	1.86	1.48	1.94	1.54	1.15
n-Butane	3.94	4.98	4.57	3.73	4.10	4.39	3.84	4.29	4.39	6.33	7.76	5.39	4.45	5.38	6.27	5.27	5.01	5.30
i-Butane	12.76	14.04	13.01	12.88	13.40	14.16	13.38	13.92	14.47	15.10	19.05	16.82	14.64	15.98	16.25	15.24	15.51	15.31
cycloPentane	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Pentenes	0.87	1.07	0.77	0.96	1.16	0.53	0.98	0.96	0.87	1.11	0.45	0.59	0.88	0.54	0.56	1.11	0.63	0.56
n-Pentane	2.76	2.39	2.76	2.53	2.30	2.53	2.58	2.59	2.47	2.70	3.37	2.44	1.55	2.27	2.49	2.51	2.39	2.29
i-Pentane	12.33	11.42	12.55	11.13	10.98	12.27	11.74	11.33	11.94	12.31	14.31	11.25	7.59	10.27	10.94	11.32	10.72	10.07
Thiophene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	1.10	0.66	1.19	1.08	0.65	1.14	0.51	0.55	0.55	0.82	0.82	0.87	0.91	0.98	0.89	0.72	0.85	0.83
C6 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	1.81	1.58	1.75	1.83	1.86	1.85	1.35	1.44	1.43	1.72	1.19	1.06	1.54	1.39	0.96	1.52	1.22	0.95
Hexanes	6.55	6.89	6.81	6.00	6.88	6.48	6.19	5.72	5.81	5.20	4.58	4.31	4.82	5.13	4.60	4.74	4.71	3.93
Toluene	1.08	0.56	0.49	1.08	0.58	0.42	0.40	0.57	0.55	1.42	1.20	1.66	1.54	1.52	1.50	1.30	1.49	1.58
C7 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	2.23	1.48	1.74	2.03	1.53	1.71	1.80	1.58	1.52	0.97	1.13	0.85	1.70	1.70	1.46	1.04	1.25	0.89
Heptanes	5.48	5.36	5.26	5.55	5.57	5.03	4.96	4.30	4.35	2.92	2.78	2.83	3.89	4.45	3.36	2.63	3.15	2.46
C8 alkylBenzenes	1.98	1.58	1.17	2.13	1.53	1.24	1.70	1.34	2.35	4.52	3.23	5.84	4.29	3.81	4.44	3.72	4.22	5.37
C8 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	1.68	1.28	1.31	1.82	1.32	1.30	1.35	1.28	1.01	0.73	0.57	0.55	1.06	1.07	0.69	0.40	0.48	0.32
Octanes	3.50	3.57	3.10	3.79	3.69	3.08	3.91	3.40	2.85	1.82	1.22	1.50	3.13	2.90	2.29	2.08	2.25	1.90
Indanes	0.29	0.31	0.38	0.31	0.32	0.37	0.35	0.34	0.28	0.18	0.13	0.11	0.53	0.49	0.27	0.34	0.36	0.20
C9 alkylBenzenes	1.88	1.89	1.97	1.82	1.95	1.95	2.38	1.63	2.02	3.94	2.93	3.97	4.81	4.33	3.94	3.53	3.82	3.54
C9 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	0.14	0.10	0.14	0.16	0.11	0.14	0.05	0.10	0.14	0.04	0.00	0.03	0.05	0.00	0.00	0.04	0.00	0.04
Nonanes	3.21	2.45	1.93	3.48	2.53	1.90	3.18	2.88	3.59	1.14	0.91	0.45	1.98	1.92	0.81	0.75	0.88	0.29
C10 Aromatics	3.21	3.21	2.98	3.48	3.32	2.92	3.38	3.40	2.94	3.33	2.52	2.81	5.24	5.09	3.71	3.40	3.90	2.94
C10 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	2.35	1.68	1.48	2.55	1.74	1.44	2.31	1.87	2.07	0.14	0.10	0.17	0.42	0.40	0.42	0.17	0.20	0.21
C11 Aromatics	3.28	4.18	3.78	3.53	4.32	3.71	4.28	4.40	4.19	2.70	1.92	2.95	3.85	3.28	3.33	2.82	2.98	3.13
C11 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	1.34	1.33	1.32	1.48	1.37	1.30	2.11	1.53	1.47	0.18	0.13	0.10	0.21	0.22	0.11	0.13	0.16	0.39
C12 Aromatics	2.68	3.27	2.98	2.91	3.37	2.92	2.58	3.11	2.82	3.11	1.81	2.89	3.44	2.23	2.45	4.27	3.22	3.58
C12 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	0.87	0.77	0.85	0.73	0.79	0.83	1.20	0.91	0.78	0.00	0.00	0.00	0.21	0.08	0.00	0.17	0.38	0.30
C13 Aromatics	1.49	1.96	1.93	1.81	2.06	1.90	1.85	2.39	1.99	3.92	0.99	3.85	2.22	0.71	1.72	5.37	2.05	4.84
C13 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	0.24	0.20	0.19	0.28	0.21	0.19	0.20	0.28	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Aromatics	1.20	1.22	1.13	1.30	1.27	1.11	1.80	1.92	1.43	0.46	0.42	0.35	1.27	1.20	0.80	0.88	0.97	0.68
C14 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.10	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	0.98	1.12	1.55	1.04	1.18	1.53	1.10	1.58	0.83	0.81	0.36	0.51	1.43	0.85	0.78	1.44	0.93	0.95
C15 Olefins	0.43	0.26	0.81	0.47	0.26	0.80	0.50	0.19	0.80	0.44	0.08	0.27	0.58	0.13	0.31	0.73	0.20	0.47
C15 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	0.82	0.87	0.75	0.88	0.90	0.74	0.80	0.77	0.80	0.49	0.23	0.23	0.74	0.45	0.31	0.99	0.56	0.42
C16 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	0.58	0.87	0.85	0.62	0.90	0.83	0.70	0.77	0.51	0.11	0.05	0.06	0.53	0.40	0.27	0.40	0.36	0.25
C17 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	0.62	0.66	0.85	0.68	0.68	0.83	0.55	0.57	0.80	0.00	0.00	0.00	0.05	0.04	0.04	0.08	0.08	0.07

Table 3.8.2 (con't)
Hydrothermal Deactivation of Cracking Catalyst
Blend C

Catalyst Deactivation	Steamed 8hrs			Steamed 16hrs			Steamed 32hrs			Thermal 4hrs			Thermal 8hrs			Thermal 16hrs		
Contact Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
MICROACTIVITY TEST - Yield Stuctures mass %FF																		
PRODUCTS																		
H2 - C2	1.22	1.72	1.96	1.24	1.59	1.78	1.09	1.37	1.70	1.95	2.41	2.39	1.46	1.81	1.99	1.55	1.50	2.04
C3C4	27.80	27.19	27.44	25.66	25.07	25.58	24.24	25.45	26.48	29.54	34.73	30.81	29.77	28.22	29.75	28.00	24.08	29.18
C5'S	12.12	9.98	10.25	10.79	11.45	8.07	9.87	9.71	8.99	12.90	14.87	11.25	13.65	13.25	12.56	12.52	10.99	11.95
C5 + Gasoline	52.40	51.60	51.07	54.96	53.12	53.33	55.90	54.18	52.57	49.72	45.02	46.46	51.07	51.41	49.29	49.82	53.42	48.40
C6 + Gasoline	40.27	41.52	40.82	44.17	41.66	45.26	46.03	44.47	43.58	36.82	30.15	35.21	37.43	38.16	36.72	37.30	42.43	36.45
Light Cycle Oil	11.58	10.78	10.13	11.40	11.82	10.03	12.34	11.99	11.39	9.95	6.96	8.74	10.70	9.54	9.00	10.53	10.45	9.55
Decant Oil	1.52	1.24	1.19	1.28	1.35	1.02	1.66	1.50	1.53	0.87	0.73	1.01	1.10	1.07	0.81	1.13	0.99	1.00
Coke	5.49	7.47	8.22	5.46	6.06	7.25	4.77	5.52	6.33	9.07	10.15	10.59	5.89	8.16	9.18	6.77	5.69	10.85
Conversion	86.90	87.98	88.68	87.32	86.83	88.95	86.00	86.51	87.08	90.18	92.31	90.25	88.20	89.39	90.19	88.34	88.56	89.45

COMPOSITIONAL YIELDS - mass %FF

COMPONENTS	Steamed 8hrs 60	Steamed 8hrs 120	Steamed 8hrs 200	Steamed 16hrs 60	Steamed 16hrs 120	Steamed 16hrs 200	Steamed 32hrs 60	Steamed 32hrs 120	Steamed 32hrs 200	Thermal 4hrs 60	Thermal 4hrs 120	Thermal 4hrs 200	Thermal 8hrs 60	Thermal 8hrs 120	Thermal 8hrs 200	Thermal 16hrs 60	Thermal 16hrs 120	Thermal 16hrs 200
Hydrogen	0.03	0.08	0.22	0.04	0.06	0.07	0.05	0.06	0.09	0.08	0.13	0.13	0.05	0.06	0.08	0.06	0.08	0.11
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.26	0.26	0.28	0.24	0.32	0.13	0.22	0.26	0.25	0.33	0.40	0.33	0.28	0.28	0.31	0.29	0.25	0.31
Methane	0.31	0.45	0.51	0.31	0.44	0.45	0.28	0.38	0.46	0.50	0.67	0.68	0.40	0.46	0.58	0.43	0.43	0.60
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylene	0.48	0.63	0.80	0.48	0.54	0.45	0.40	0.47	0.58	0.70	0.79	0.78	0.50	0.52	0.62	0.80	0.49	0.62
Ethane	0.38	0.55	0.61	0.40	0.54	0.78	0.36	0.46	0.58	0.57	0.81	0.78	0.50	0.58	0.71	0.55	0.50	0.70
Propyne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propadiene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propene	4.76	3.90	3.71	4.61	3.87	3.25	4.45	4.44	4.34	4.48	4.24	3.51	4.84	4.18	3.80	4.21	3.34	3.31
Propene	3.04	3.95	4.22	2.61	3.55	3.78	2.30	2.80	3.48	4.09	5.77	5.71	3.42	3.77	4.84	3.95	3.43	4.83
1,3-Butadiene	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00
Butenes	2.57	1.58	1.51	2.29	1.52	2.72	2.38	2.09	1.81	1.68	1.48	1.24	2.18	1.97	1.58	1.43	1.48	1.35
n-Butane	4.46	4.94	4.94	4.25	4.76	3.36	3.84	4.29	4.47	5.67	7.08	6.13	5.18	5.41	5.82	5.45	4.70	5.85
i-Butane	12.85	12.75	12.97	11.79	12.29	13.24	11.18	11.76	12.32	13.40	15.92	14.01	12.97	12.75	13.68	12.77	11.08	13.01
cycloPentene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pentenes	0.70	0.80	0.51	0.80	0.80	0.28	0.58	0.55	0.45	0.49	0.53	0.52	0.81	0.68	0.66	0.54	0.64	0.58
n-Pentane	2.28	1.90	1.98	2.02	2.28	0.71	1.88	1.82	1.87	2.52	2.78	2.21	2.62	2.50	2.40	2.46	2.22	2.32
i-Pentane	10.41	8.94	9.38	9.32	9.78	8.50	8.77	8.88	8.41	10.62	12.20	9.42	11.23	11.02	10.50	10.68	9.54	10.19
Thiophene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiocyclopentane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	1.17	1.41	1.38	1.26	1.43	1.25	1.10	1.30	1.19	1.25	1.18	1.33	1.14	1.23	1.28	1.46	1.62	1.73
C6 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexenes	1.22	1.80	1.22	1.59	1.75	1.14	1.28	1.55	1.13	1.39	1.17	1.08	1.48	1.35	1.28	1.53	1.37	1.12
Hexanes	5.05	5.14	4.78	5.18	5.93	4.95	4.62	5.28	4.50	4.78	4.54	4.48	5.28	5.22	5.05	5.63	5.89	5.46
Toluene	1.06	1.48	1.42	1.44	1.77	1.71	1.18	1.55	1.44	1.81	1.30	1.94	1.38	1.32	1.53	1.49	1.63	1.73
C7 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heptenes	2.29	2.21	2.16	2.55	2.20	8.37	2.89	2.75	2.69	1.98	1.20	1.98	2.02	1.55	1.94	2.36	2.10	2.33
Heptanes	4.31	4.74	4.27	4.93	5.03	4.30	4.68	4.88	4.27	3.76	2.98	3.19	4.44	4.14	3.89	4.53	4.71	3.90
C8 alkylBenzenes	2.31	3.58	2.68	3.33	4.52	3.67	2.86	3.85	2.98	4.34	3.46	4.64	3.29	3.33	3.47	3.64	4.20	3.94
C8 cycloOlefins	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octenes	0.91	1.00	0.89	1.11	1.07	0.98	0.96	0.97	0.87	0.78	0.80	0.85	0.99	0.98	0.86	0.84	0.95	0.73
Octanes	3.54	3.99	3.06	4.22	3.91	3.57	3.99	4.01	3.48	2.59	1.87	2.07	3.47	3.09	2.86	3.28	3.42	2.59
Indanes	0.52	0.63	0.54	0.89	0.80	0.72	0.88	0.88	0.72	0.49	0.42	0.47	0.61	0.66	0.59	0.52	0.63	0.51
C9 alkylBenzenes	3.04	4.06	3.27	4.05	4.77	3.98	3.35	4.18	3.34	3.55	2.79	3.23	3.80	3.84	3.50	3.49	3.99	3.30
C9 cycloOlefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nonenes	3.37	1.90	2.41	2.77	1.38	1.88	4.01	2.12	2.74	0.83	0.67	0.48	1.83	1.87	1.04	1.45	1.58	0.82
C10 Aromatics	6.45	6.06	5.76	6.98	5.76	5.90	7.58	6.82	6.88	4.06	2.97	3.80	5.31	4.92	4.78	5.09	5.41	4.80
C10 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Paraffins	0.95	0.88	0.63	0.88	0.59	0.57	0.88	0.63	0.57	0.43	0.49	0.24	0.42	0.61	0.23	0.34	0.58	0.18
C11 Aromatics	3.83	4.27	3.96	4.22	4.18	4.08	4.33	4.58	4.23	4.42	3.29	4.11	3.90	3.75	3.79	3.51	3.94	3.42
C11 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11 Paraffins	0.76	0.53	0.58	0.87	0.43	0.52	0.90	0.83	0.71	0.45	0.25	0.20	0.81	0.42	0.27	0.73	0.58	0.33
C12 Aromatics	2.85	2.95	2.75	3.11	2.95	2.85	3.11	3.15	3.00	3.13	2.88	3.35	2.88	3.23	2.97	2.57	3.31	2.64
C12 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12 Paraffins	0.07	0.11	0.08	0.11	0.16	0.10	0.08	0.11	0.07	0.18	0.11	0.13	0.19	0.14	0.14	0.18	0.18	0.13
C13 Aromatics	1.84	1.42	1.82	1.38	0.96	1.24	2.07	1.55	1.98	1.15	1.38	1.81	1.13	1.78	1.82	0.84	1.47	1.21
C13 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13 Paraffins	0.05	0.00	0.05	0.00	0.00	0.05	0.06	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Aromatics	3.00	1.79	3.41	2.00	1.29	2.12	3.92	2.41	4.42	1.80	1.38	1.89	1.55	1.73	1.58	1.54	1.94	1.84
C14 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C14 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C15 Aromatics	1.92	1.32	1.97	1.33	0.88	1.28	2.38	1.43	2.18	1.80	1.10	2.01	1.08	0.94	1.35	1.52	1.37	1.78
C15 Olefins	0.07	0.05	0.07	0.11	0.00	0.05	0.08	0.06	0.08	0.31	0.18	0.35	0.33	0.23	0.36	0.33	0.26	0.34
C15 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Aromatics	0.85	0.63	0.69	0.61	0.54	0.62	0.78	0.89	0.80	0.62	0.49	0.76	0.52	0.52	0.63	0.45	0.53	0.58
C16 Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C16 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C17 Aromatics	0.57	0.63	0.44	0.83	0.88	0.62	0.70	0.74	0.51	0.52	0.38	0.38	0.86	0.88	0.50	0.34	0.37	0.24
C17 Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C18+	0.07	0.11	0.07	0.11	0.16	0.10	0.08	0.11	0.07	0.03	0.04	0.03	0.08	0.14	0.08	0.03	0.05	0.03

Table 3.8.3
Hydrothermal Deactivation of Cracking Catalyst
Extreme Thermal Deactivation
(899 C for 16 hours)

MICROACTIVITY TEST - Yield Structures mass %FF

		Blend B	
Contact Time (s)	60	120	200
Products			
H2	0.00	0.02	0.02
C1	0.05	0.08	0.08
C2	0.12	0.16	0.11
H2-C2	0.17	0.25	0.21
C3	4.22	5.34	4.98
C4	9.77	12.55	11.81
C3C4	14.00	17.88	16.80
C5	6.57	7.34	8.49
C5 + Gasoline	41.80	46.72	46.89
C6 + Gasoline	35.22	39.38	38.40
LCO	41.41	32.84	33.62
DO	2.11	1.73	1.75
Coke	0.51	0.58	0.74
Conversion	56.47	65.43	64.63

Table 3.9.1
The Effects of Metals Impregnation on Catalyst Cracking
Catalyst Metals Loading

		Nickel	Vanadium	Nickel Equivalence
N-500	XC041DH	491	64	507
N-1000	XC042DH	990	55	1004
N-2000	XC043DH	1875	72	1893
V-500	XC044DH	80	567	222
V-1000	XC045DH	80	980	325
V-2000	XC045DH	80	1960	570
NV-1000	XC046DH	489	549	626
NV-2000	XC047DH	988	1155	1277
NV-4000	XC048DH	1986	2057	2500

Nickel equivalence are calculated as:

$$NEq = Ni + V/4$$

Table 3.9.2
The Effects of Metals Impregnation on Catalyst Cracking
Blend A
60 s Injection Time

Catalyst		N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	5.44	5.66	5.32	5.45	5.49	5.50	5.29	5.74	5.79
C3C4	:	22.77	22.31	20.73	20.73	20.45	20.13	20.90	19.40	18.69
C5'S	:	13.03	12.70	12.34	13.25	11.86	12.44	12.41	11.41	10.99
C5 + Gasoline	:	52.75	52.03	53.30	56.42	56.19	56.06	55.16	54.28	51.88
C6 + Gasoline	:	39.72	39.33	40.96	43.17	43.43	43.62	42.75	42.87	40.89
Light Cycle Oil	:	8.90	8.72	9.99	9.23	9.43	9.47	9.49	10.28	11.79
Decant Oil	:	2.04	2.30	2.54	1.96	1.96	1.98	2.14	2.53	3.36
Coke	:	8.09	8.97	8.13	6.20	6.47	6.88	7.01	7.77	8.48
Conversion	:	89.06	88.98	87.47	88.81	88.60	88.55	88.37	87.19	84.84
REACTOR EFFLUENT GAS (REG %FF)										
Hydrogen	:	0.12	0.14	0.19	0.04	0.05	0.07	0.09	0.15	0.21
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	4.18	4.48	3.95	4.08	4.42	4.27	4.12	4.34	4.35
Carbon Dioxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	:	0.25	0.33	0.22	0.31	0.23	0.33	0.29	0.29	0.27
Ethane	:	0.35	0.40	0.32	0.51	0.35	0.43	0.37	0.42	0.35
Ethylene	:	0.46	0.50	0.43	0.54	0.33	0.41	0.41	0.42	0.41
Propane	:	2.67	2.05	1.69	2.26	1.45	2.01	1.98	1.82	1.67
Propene	:	4.77	4.94	4.88	4.31	4.75	4.49	4.76	4.48	4.35
i-Butane	:	8.80	8.83	7.78	8.07	6.33	7.39	7.75	6.91	6.61
n-Butane	:	2.26	2.28	1.80	2.21	1.51	2.02	1.98	1.80	1.65
1-Butene	:	1.50	1.52	1.66	1.22	1.71	1.38	1.45	1.52	1.61
2-Methylpropene	:	0.25	0.25	0.27	0.20	0.28	0.23	0.23	0.25	0.26
trans-2-Butene	:	1.59	1.67	1.73	1.35	1.84	1.49	1.54	1.64	1.68
cis-2-Butene	:	1.15	1.18	1.24	0.96	1.29	1.05	1.10	1.17	1.19
i-Pentane	:	7.44	7.90	6.87	6.63	5.50	6.24	6.26	6.23	5.99
n-Pentane	:	0.58	0.64	0.57	0.54	0.51	0.53	0.50	0.56	0.54
1-Pentene	:	0.10	0.07	0.12	0.12	0.13	0.10	0.06	0.09	0.12
2-Methyl-1-Butene	:	0.20	0.17	0.20	0.00	0.21	0.15	0.15	0.00	0.20
trans-2-Pentene	:	0.26	0.20	0.28	0.39	0.32	0.23	0.16	0.25	0.32
cis-2-Pentene	:	0.29	0.24	0.27	0.27	0.32	0.27	0.18	0.25	0.27
2-Methyl-2-Butene	:	0.43	0.42	0.45	0.55	0.52	0.43	0.34	0.43	0.54
C6+	:	2.47	2.36	2.39	2.03	2.07	2.01	1.97	2.36	2.57

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend A
120 s Injection Time

MICROACTIVITY TEST-Yield Stuctures mass %FF

Catalyst		N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
PRODUCTS										
H2 - C2	:	6.10	5.96	6.08	5.65	5.90	6.41	6.86	6.62	6.08
C3C4	:	23.60	23.34	20.73	24.50	24.53	23.53	25.45	22.21	20.17
C5'S	:	13.22	13.30	12.02	14.61	11.49	10.89	13.54	12.18	11.69
C5 + Gasoline	:	49.73	50.40	50.81	51.62	51.88	52.26	50.34	51.97	50.23
C6 + Gasoline	:	36.51	37.10	38.79	37.01	38.88	41.37	36.80	39.79	38.54
Light Cycle Oil	:	7.84	7.66	8.57	6.95	8.47	9.26	7.36	8.57	9.32
Decant Oil	:	2.39	2.34	2.42	1.62	2.01	2.39	1.93	2.33	2.74
Coke	:	10.35	10.30	11.37	9.66	7.21	6.14	8.05	8.30	11.47
Conversion	:	89.78	90.00	89.01	91.42	89.51	88.34	90.71	89.10	87.94

REACTOR EFFLUENT GAS (REG %FF)

		N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
Hydrogen	:	0.15	0.17	0.24	0.06	0.07	0.12	0.13	0.21	0.29
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	4.34	4.14	4.23	3.35	3.97	4.51	4.18	4.57	4.06
Carbon Dioxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	:	0.38	0.37	0.35	0.51	0.29	0.51	0.43	0.42	0.39
Ethane	:	0.55	0.56	0.49	0.68	0.48	0.66	0.62	0.54	0.51
Ethylene	:	0.62	0.63	0.55	0.66	0.40	0.55	0.57	0.50	0.52
Propane	:	3.03	2.93	2.13	3.49	1.82	2.91	2.63	2.35	2.18
Propene	:	4.57	4.55	4.68	4.71	4.48	4.89	4.66	4.72	4.53
i-Butane	:	9.84	9.69	8.09	11.40	6.38	9.21	8.75	8.14	7.51
n-Butane	:	2.69	2.65	2.08	3.28	1.69	2.78	2.47	2.31	2.01
1-Butene	:	1.23	1.28	1.44	1.11	1.47	1.34	1.30	1.49	1.54
2-Methylpropene	:	0.20	0.21	0.24	0.18	0.24	0.22	0.21	0.24	0.25
trans-2-Butene	:	1.34	1.36	1.52	1.26	1,57	1.52	1.48	1.59	1.59
cis-2-Butene	:	0.96	0.97	1.08	0.89	1.12	1.08	1.04	1.15	1.13
i-Pentane	:	7.89	7.95	7.33	8.96	5.28	8.03	7.91	7.45	6.96
n-Pentane	:	0.66	0.67	0.66	0.77	0.46	0.70	0.66	0.65	0.66
1-Pentene	:	0.05	0.06	0.07	0.03	0.07	0.05	0.04	0.10	0.15
2-Methyl-1-Butene	:	0.14	0.20	0.18	0.00	0.17	0.32	0.17	0.22	0.22
trans-2-Pentene	:	0.15	0.14	0.20	0.21	0.19	0.00	0.13	0.23	0.26
cis-2-Pentene	:	0.20	0.25	0.22	0.14	0.21	0.00	0.20	0.24	0.36
2-Methyl-2-Butene	:	0.30	0.33	0.44	0.27	0.38	0.30	0.31	0.44	0.54
C6+	:	2.39	2.51	2.78	2.70	1.89	2.58	2.76	2.82	2.97

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend A
200 s Injection Time

MICROACTIVITY TEST-Yield Stuctures mass %FF

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
PRODUCTS									
H2 - C2	6.34	6.34	6.63	6.28	6.39	6.43	6.61	6.56	6.35
C3C4	24.76	23.98	22.86	25.34	24.35	23.35	24.20	22.59	21.76
C5'S	13.26	12.81	12.79	13.80	11.86	12.25	12.65	13.11	12.24
C5 + Gasoline	47.59	48.21	49.01	49.13	49.30	49.58	48.99	49.71	47.80
C6 + Gasoline	34.33	35.40	36.22	35.33	36.33	37.33	36.34	36.60	35.56
Light Cycle Oil	6.95	7.76	7.13	6.66	7.49	8.37	6.59	6.74	7.85
Decant Oil	1.76	2.02	1.93	1.50	1.70	1.98	1.50	1.52	1.74
Coke	12.60	11.70	12.44	11.11	10.78	10.29	12.11	12.86	14.50
Conversion	91.28	90.22	90.94	91.84	90.82	89.65	91.91	91.75	90.41

REACTOR EFFLUENT GAS (REG %FF)

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
Hydrogen	0.17	0.17	0.27	0.07	0.10	0.16	0.15	0.24	0.33
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	4.15	4.13	4.31	4.16	4.16	3.77	4.22	4.07	3.85
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.50	0.54	0.46	0.61	0.42	0.79	0.61	0.59	0.58
Ethane	0.71	0.74	0.66	0.77	0.63	0.98	0.86	0.81	0.61
Ethylene	0.71	0.67	0.68	0.70	0.48	0.67	0.72	0.66	0.60
Propane	3.49	2.87	2.56	3.94	2.43	4.19	3.33	2.80	2.58
Propene	4.59	5.26	5.04	4.31	4.58	3.70	4.75	4.75	4.73
i-Butane	10.58	9.09	8.84	11.01	7.22	9.97	9.83	8.64	8.20
n-Butane	3.08	2.54	2.46	3.48	2.08	3.45	3.02	2.57	2.28
1-Butene	1.19	1.51	1.52	0.96	1.30	0.83	1.19	1.45	1.71
2-Methylpropene	0.19	0.25	0.25	0.16	0.21	0.14	0.19	0.23	0.28
trans-2-Butene	1.24	1.67	1.63	1.08	1.37	0.89	1.38	1.55	1.59
cis-2-Butene	0.89	1.19	1.16	0.78	0.97	0.63	0.98	1.13	1.14
i-Pentane	8.56	8.00	8.28	9.34	5.44	8.38	8.94	8.22	7.40
n-Pentane	0.71	0.68	0.73	0.74	0.47	0.75	0.75	0.80	0.82
1-Pentene	0.03	0.07	0.14	0.07	0.06	0.00	0.04	0.09	0.16
2-Methyl-1-Butene	0.15	0.19	0.22	0.28	0.00	0.17	0.00	0.00	0.31
trans-2-Pentene	0.10	0.19	0.22	0.00	0.13	0.00	0.25	0.19	0.32
cis-2-Pentene	0.24	0.20	0.29	0.00	0.17	0.00	0.07	0.33	0.34
2-Methyl-2-Butene	0.32	0.40	0.49	0.25	0.33	0.16	0.25	0.75	0.68
C6+	2.60	2.79	3.31	2.80	1.70	2.45	2.95	3.49	3.29

Table 3.9.2
The Effects of Metals Impregnation on Catalyst Cracking
Blend B
60 s Injection Time

MICROACTIVITY TEST-Yield Stuctures mass %FF

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
PRODUCTS									
H2 - C2	1.21	1.29	1.12	1.14	1.11	1.10	1.10	1.30	1.31
C3C4	24.53	25.74	21.42	25.47	25.13	24.36	23.87	23.52	23.52
C5'S	12.98	12.85	11.81	13.43	12.04	12.81	12.85	12.69	12.42
C5 + Gasoline	56.61	55.74	58.11	57.89	58.30	59.18	59.68	59.19	57.21
C6 + Gasoline	43.63	42.89	46.30	44.46	45.24	46.37	46.83	46.50	44.79
Light Cycle Oil	9.16	8.97	10.85	8.87	8.96	8.90	9.18	9.24	9.78
Decant Oil	1.56	1.52	1.91	1.53	1.48	1.46	1.59	1.65	1.70
Coke	6.91	6.74	6.60	5.10	5.03	4.99	5.01	5.08	6.50
Conversion	89.28	89.51	87.24	89.60	89.57	89.63	89.23	89.11	88.52

REACTOR EFFLUENT GAS (REG %FF)

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
Hydrogen	0.09	0.06	0.14	0.02	0.03	0.04	0.04	0.06	0.11
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.22	0.27	0.15	0.28	0.19	0.29	0.27	0.40	0.29
Ethane	0.26	0.30	0.18	0.30	0.23	0.31	0.29	0.35	0.30
Ethylene	0.54	0.61	0.42	0.52	0.32	0.43	0.47	0.44	0.45
Propane	2.82	3.27	1.91	2.88	1.56	2.64	2.34	2.22	2.33
Propene	3.80	3.74	3.83	3.92	4.25	4.06	3.98	4.00	3.96
i-Butane	13.04	13.74	11.14	13.44	11.09	12.50	12.51	12.26	12.25
n-Butane	2.33	2.64	1.60	2.45	1.54	2.05	2.05	1.93	2.05
1-Butene	0.91	0.84	1.10	0.88	1.31	0.98	0.96	1.00	1.09
2-Methylpropene	0.17	0.16	0.21	0.17	0.25	0.18	0.18	0.19	0.21
trans-2-Butene	0.89	0.84	1.04	0.92	1.21	1.00	0.97	1.00	1.05
cis-2-Butene	0.63	0.59	0.73	0.65	0.84	0.70	0.68	0.71	0.75
i-Pentane	7.42	7.65	6.70	7.41	6.16	6.79	6.90	6.87	7.45
n-Pentane	0.44	0.45	0.36	0.43	0.32	0.39	0.36	0.39	0.43
1-Pentene	0.06	0.03	0.05	0.03	0.05	0.01	0.03	0.03	0.04
2-Methyl-1-Butene	0.09	0.06	0.10	0.07	0.10	0.05	0.16	0.08	0.10
trans-2-Pentene	0.06	0.03	0.12	0.06	0.14	0.04	0.00	0.00	0.08
cis-2-Pentene	0.08	0.00	0.13	0.09	0.12	0.00	0.00	0.06	0.09
2-Methyl-2-Butene	0.15	0.10	0.25	0.13	0.22	0.14	0.13	0.17	0.19
C6+	1.99	2.00	2.14	1.92	1.86	1.85	1.87	1.96	2.22

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend B
120 s Injection Time

MICROACTIVITY TEST-Yield Stuctures mass %FF

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
PRODUCTS									
H2 - C2	1.63	1.57	1.71	1.55	1.55	1.64	1.80	1.53	1.69
C3C4	27.74	27.39	25.63	27.45	26.97	26.19	26.50	24.49	25.06
C5'S	13.60	14.02	13.38	14.21	12.63	13.78	13.88	13.15	12.75
C5 + Gasoline	52.69	54.59	55.29	55.82	55.79	55.96	55.95	57.54	55.99
C6 + Gasoline	39.09	40.57	41.91	41.61	41.96	42.18	42.07	44.39	42.24
Light Cycle Oil	7.94	7.99	7.84	7.64	7.89	8.17	8.07	8.77	8.84
Decant Oil	1.37	1.29	1.43	1.04	1.20	1.43	1.15	1.59	1.61
Coke	8.62	7.17	8.09	6.52	6.59	6.60	6.53	6.09	7.81
Conversion	90.68	90.72	90.73	91.32	90.91	90.40	90.78	89.65	89.55

REACTOR EFFLUENT GAS (REG %FF)

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
Hydrogen	0.11	0.07	0.19	0.03	0.05	0.06	0.06	0.09	0.16
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.30	0.33	0.29	0.38	0.27	0.45	0.52	0.40	0.36
Ethane	0.37	0.38	0.32	0.43	0.32	0.48	0.47	0.42	0.39
Ethylene	0.72	0.72	0.62	0.67	0.40	0.60	0.67	0.53	0.54
Propane	3.84	3.82	2.57	3.81	2.15	3.23	3.27	2.78	3.55
Propene	3.77	3.72	4.36	3.74	4.26	3.97	3.93	3.86	3.93
i-Butane	15.08	14.78	13.81	14.70	12.01	14.03	14.30	12.91	12.76
n-Butane	2.99	2.97	2.24	2.94	1.83	2.67	2.70	2.30	2.34
1-Butene	0.72	0.68	1.00	0.68	0.98	0.77	0.76	0.80	0.90
2-Methylpropene	0.14	0.13	0.17	0.11	0.16	0.13	0.13	0.13	0.15
trans-2-Butene	0.75	0.72	1.05	0.71	1.07	0.83	0.82	0.87	0.92
cis-2-Butene	0.53	0.50	0.73	0.51	0.75	0.58	0.58	0.61	0.64
i-Pentane	8.64	8.09	8.47	7.76	6.49	8.05	8.16	7.12	7.47
n-Pentane	0.52	0.44	0.43	0.43	0.36	0.46	0.42	0.41	0.44
1-Pentene	0.02	0.02	0.02	0.01	0.03	0.03	0.03	0.02	0.02
2-Methyl-1-Butene	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
trans-2-Pentene	0.00	0.11	0.19	0.09	0.19	0.19	0.14	0.15	0.07
cis-2-Pentene	0.00	0.07	0.09	0.02	0.00	0.09	0.06	0.00	0.12
2-Methyl-2-Butene	0.16	0.14	0.24	0.10	0.15	0.21	0.14	0.14	0.22
C6+	2.27	2.08	2.77	1.92	1.81	2.22	2.27	2.00	2.18

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend B
200 s Injection Time

Catalyst		N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	1.78	2.00	1.83	1.87	1.90	1.89	1.89	2.01	2.14
C3C4	:	27.28	29.31	24.59	28.80	27.22	26.63	27.27	26.01	25.95
C5'S	:	14.00	14.66	13.13	14.73	13.57	14.54	14.34	13.97	13.44
C5 + Gasoline	:	53.45	52.52	54.46	53.68	54.94	55.35	54.95	55.33	52.90
C6 + Gasoline	:	39.45	37.86	41.33	38.95	40.42	40.81	40.61	41.36	39.46
Light Cycle Oil	:	7.93	6.81	8.43	7.46	7.66	7.78	7.64	7.83	8.11
Decant Oil	:	1.15	0.88	1.57	0.96	1.01	1.07	1.28	1.08	1.46
Coke	:	8.42	8.48	9.14	7.21	7.28	7.29	6.97	7.75	9.43
Conversion	:	90.92	92.32	90.00	91.57	91.33	91.15	91.08	91.09	90.42
REACTOR EFFLUENT GAS (REG %FF)										
Hydrogen	:	0.13	0.09	0.21	0.05	0.07	0.08	0.08	0.12	0.20
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	:	0.37	0.46	0.33	0.50	0.35	0.52	0.50	0.55	0.52
Ethane	:	0.42	0.51	0.36	0.54	0.38	0.57	0.53	0.57	0.51
Ethylene	:	0.73	0.85	0.61	0.75	0.45	0.63	0.70	0.62	0.61
Propane	:	3.96	4.65	2.61	4.34	2.42	3.55	3.62	3.39	3.21
Propene	:	3.71	3.61	4.15	3.67	4.29	3.83	3.97	3.83	4.10
i-Butane	:	14.66	15.97	13.19	15.56	12.41	14.23	14.57	13.88	13.77
n-Butane	:	2.93	3.43	2.17	3.32	2.02	2.83	2.83	2.63	2.58
1-Butene	:	0.70	0.62	0.92	0.65	0.94	0.71	0.74	0.76	0.94
2-Methylpropene	:	0.11	0.10	0.15	0.10	0.15	0.11	0.12	0.12	0.15
trans-2-Butene	:	0.69	0.62	0.93	0.66	1.01	0.76	0.78	0.78	0.93
cis-2-Butene	:	0.50	0.44	0.64	0.47	0.71	0.53	0.55	0.55	0.66
i-Pentane	:	8.25	9.11	7.83	8.87	7.00	8.20	8.20	7.99	8.62
n-Pentane	:	0.45	0.51	0.42	0.49	0.36	0.48	0.46	0.47	0.52
1-Pentene	:	0.02	0.02	0.03	0.01	0.04	0.04	0.01	0.02	0.05
2-Methyl-1-Butene	:	0.00	0.00	0.00	0.00	0.10	0.19	0.20	0.10	0.12
trans-2-Pentene	:	0.07	0.04	0.16	0.07	0.06	0.08	0.00	0.00	0.10
cis-2-Pentene	:	0.00	0.00	0.08	0.00	0.09	0.11	0.00	0.00	0.15
2-Methyl-2-Butene	:	0.06	0.13	0.18	0.14	0.17	0.17	0.14	0.15	0.24
C6+	:	2.24	2.36	2.50	2.35	2.12	2.35	2.15	2.31	2.85

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend C
60 s Injection Time

Catalyst		N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	:	1.28	1.41	1.38	1.12	1.16	1.16	1.28	1.28	1.46
C3C4	:	23.18	24.07	21.90	22.10	21.17	21.45	22.58	21.27	20.71
C5'S	:	11.61	12.11	10.19	11.70	10.74	11.43	11.84	11.32	10.91
C5 + Gasoline	:	54.22	54.30	54.09	57.04	57.77	57.58	56.48	57.18	55.01
C6 + Gasoline	:	42.61	42.19	43.90	45.34	46.38	46.15	44.64	45.86	44.10
Light Cycle Oil	:	12.69	11.90	13.56	12.75	12.90	13.00	12.36	13.03	14.07
Decant Oil	:	1.74	1.52	1.91	1.65	1.70	1.68	1.60	1.72	1.80
Coke	:	6.90	6.80	7.13	5.33	5.29	5.12	5.72	5.52	6.95
Conversion	:	85.57	86.57	84.53	85.61	85.39	85.32	86.04	85.25	84.13
REACTOR EFFLUENT GAS (REG %FF)										
Hydrogen	:	0.09	0.07	0.16	0.03	0.04	0.05	0.05	0.08	0.13
Carbon Monoxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	:	0.21	0.27	0.19	0.25	0.18	0.30	0.30	0.31	0.32
Ethane	:	0.29	0.33	0.27	0.31	0.22	0.32	0.33	0.34	0.35
Ethylene	:	0.56	0.65	0.50	0.52	0.31	0.44	0.53	0.45	0.46
Propane	:	3.15	3.29	2.26	2.90	1.69	2.29	2.67	2.35	2.38
Propene	:	3.54	3.67	3.91	3.36	3.74	3.64	3.72	3.61	3.52
i-Butane	:	11.65	12.09	11.18	11.03	9.19	10.66	11.31	10.50	10.23
n-Butane	:	2.69	2.84	2.20	2.57	1.69	2.27	2.49	2.24	2.23
1-Butene	:	0.74	0.73	0.95	0.66	0.97	0.77	0.75	0.82	0.84
2-Methylpropene	:	0.12	0.12	0.15	0.11	0.16	0.13	0.12	0.13	0.14
trans-2-Butene	:	0.79	0.79	1.04	0.75	1.06	0.87	0.87	0.93	0.91
cis-2-Butene	:	0.55	0.56	0.72	0.53	0.73	0.61	0.62	0.65	0.64
i-Pentane	:	6.70	7.08	6.96	6.29	5.30	6.06	6.74	6.34	6.38
n-Pentane	:	0.45	0.48	0.45	0.39	0.33	0.43	0.43	0.42	0.43
1-Pentene	:	0.02	0.02	0.03	0.02	0.05	0.02	0.04	0.02	0.02
2-Methyl-1-Butene	:	0.00	0.00	0.09	0.00	0.07	0.11	0.00	0.00	0.00
trans-2-Pentene	:	0.11	0.10	0.09	0.05	0.09	0.08	0.12	0.12	0.14
cis-2-Pentene	:	0.08	0.00	0.09	0.09	0.02	0.00	0.06	0.04	0.10
2-Methyl-2-Butene	:	0.14	0.12	0.22	0.11	0.15	0.00	0.14	0.13	0.19
C6+	:	1.86	1.86	2.19	1.72	1.61	1.56	1.95	1.88	1.96

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend C
120 s Injection Time

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
MICROACTIVITY TEST-Yield Stuctures mass %FF									
PRODUCTS									
H2 - C2	1.64	1.79	1.65	1.68	1.60	1.53	1.60	1.69	1.77
C3C4	24.13	25.75	21.01	24.36	23.05	22.36	23.45	22.04	21.55
C5'S	11.87	12.65	10.99	12.63	10.92	11.89	12.19	11.63	11.25
C5 + Gasoline	52.06	51.87	53.82	54.21	55.01	55.19	54.62	54.60	52.99
C6 + Gasoline	40.19	39.22	42.83	41.58	42.08	43.30	42.43	42.97	41.74
Light Cycle Oil	11.59	10.89	12.93	11.32	11.52	12.03	11.74	11.94	12.67
Decant Oil	1.57	1.18	1.78	1.21	1.50	1.50	1.36	1.54	1.62
Coke	9.01	8.54	8.82	7.33	7.31	7.38	7.25	8.17	9.38
Conversion	86.85	87.93	85.29	87.43	86.97	86.46	86.90	86.52	85.70
REACTOR EFFLUENT GAS (REG %FF)									
Hydrogen	0.12	0.09	0.19	0.04	0.05	0.07	0.07	0.11	0.17
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.29	0.37	0.24	0.39	0.23	0.39	0.39	0.41	0.37
Ethane	0.39	0.46	0.33	0.46	0.32	0.46	0.45	0.49	0.43
Ethylene	0.68	0.78	0.56	0.67	0.40	0.53	0.61	0.55	0.53
Propane	3.74	4.29	2.39	3.78	2.14	3.03	3.24	2.99	2.86
Propene	3.29	3.24	3.60	3.30	3.67	3.41	3.55	3.35	3.44
i-Butane	12.52	13.34	10.74	12.44	9.86	11.27	11.92	11.22	10.84
n-Butane	3.01	3.40	2.23	3.07	1.99	2.63	2.75	2.61	2.50
1-Butene	0.62	0.58	0.81	0.55	0.81	0.65	0.64	0.68	0.76
2-Methylpropene	0.10	0.09	0.13	0.09	0.13	0.11	0.11	0.11	0.13
trans-2-Butene	0.64	0.59	0.86	0.61	0.91	0.73	0.72	0.73	0.80
cis-2-Butene	0.45	0.43	0.60	0.43	0.64	0.51	0.48	0.51	0.56
i-Pentane	7.17	7.83	6.80	7.03	5.65	6.60	6.87	6.73	6.88
n-Pentane	0.44	0.52	0.43	0.43	0.34	0.39	0.43	0.42	0.44
1-Pentene	0.02	0.00	0.03	0.05	0.02	0.05	0.00	0.03	0.03
2-Methyl-1-Butene	0.17	0.11	0.00	0.00	0.00	0.00	0.00	0.10	0.08
trans-2-Pentene	0.00	0.00	0.13	0.10	0.09	0.10	0.13	0.00	0.06
cis-2-Pentene	0.00	0.09	0.10	0.08	0.00	0.09	0.00	0.07	0.14
2-Methyl-2-Butene	0.11	0.13	0.15	0.12	0.10	0.11	0.10	0.17	0.17
C6+	1.92	2.09	2.20	1.83	1.70	1.89	1.86	2.04	2.24

Table 3.9.2(con't)
The Effects of Metals Impregnation on Catalyst Cracking
Blend C
200 s Injection Time

MICROACTIVITY TEST-Yield Stuctures mass %FF

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
PRODUCTS									
H2 - C2	1.90	1.95	2.03	1.93	1.89	1.93	1.92	2.09	2.08
C3C4	25.41	26.57	22.58	25.90	24.48	23.85	24.43	23.58	22.22
C5'S	12.25	12.41	11.40	12.65	11.22	12.07	12.18	11.90	11.32
C5 + Gasoline	50.53	50.09	51.10	51.92	53.03	52.71	52.46	52.56	51.58
C6 + Gasoline	38.28	37.68	39.70	39.27	40.80	40.64	40.28	40.66	40.26
Light Cycle Oil	11.16	10.93	12.10	10.81	10.71	11.74	11.63	11.52	12.38
Decant Oil	1.38	1.30	1.58	1.02	1.33	1.40	1.45	1.33	1.50
Coke	9.62	9.17	10.62	8.42	8.57	8.38	8.11	8.94	10.24
Conversion	87.46	87.77	86.32	88.17	87.97	86.86	86.91	87.15	86.12

REACTOR EFFLUENT GAS (REG %FF)

Catalyst	N-500	N-1000	N-2000	V-500	V-1000	V-2000	NV-1000	NV-2000	NV-4000
Hydrogen	0.13	0.09	0.22	0.06	0.08	0.10	0.09	0.14	0.20
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.38	0.44	0.36	0.50	0.34	0.51	0.49	0.53	0.46
Ethane	0.48	0.53	0.42	0.59	0.41	0.59	0.56	0.56	0.50
Ethylene	0.75	0.80	0.63	0.73	0.46	0.60	0.66	0.64	0.56
Propane	4.28	4.70	2.94	4.45	2.60	3.68	3.77	3.49	3.13
Propene	3.22	3.13	3.61	3.13	3.78	3.29	3.35	3.42	3.43
i-Butane	13.20	13.83	11.72	13.44	10.71	12.25	12.60	12.04	11.26
n-Butane	3.29	3.58	2.58	3.46	2.28	3.05	3.07	2.90	2.65
1-Butene	0.61	0.55	0.78	0.51	0.80	0.59	0.58	0.68	0.76
2-Methylpropene	0.10	0.09	0.13	0.08	0.13	0.10	0.09	0.11	0.12
trans-2-Butene	0.58	0.54	0.79	0.54	0.87	0.63	0.63	0.70	0.78
cis-2-Butene	0.41	0.38	0.57	0.38	0.61	0.44	0.45	0.50	0.54
i-Pentane	7.68	7.96	7.43	7.75	6.23	7.44	7.41	7.41	7.25
n-Pentane	0.50	0.50	0.47	0.50	0.36	0.46	0.46	0.51	0.48
1-Pentene	0.03	0.03	0.05	0.02	0.00	0.03	0.15	0.04	0.03
2-Methyl-1-Butene	0.13	0.00	0.19	0.11	0.10	0.11	0.00	0.00	0.17
trans-2-Pentene	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.10	0.00
cis-2-Pentene	0.11	0.00	0.10	0.00	0.00	0.09	0.00	0.05	0.09
2-Methyl-2-Butene	0.14	0.10	0.16	0.10	0.09	0.13	0.10	0.15	0.17
C6+	2.15	2.11	2.46	2.06	1.81	2.20	2.09	2.36	2.35

Table 3.9.3
The Effects of Metals Impregnation on Catalyst Cracking Gas Oil Feedstock

Contact Time	60 s				120 s				200 s			
Ni + V (ppm)	0	1000	2000	4000	0	1000	2000	4000	0	1000	2000	4000
MICROACTIVITY TEST-Yield Stuctures mass %FF												
PRODUCTS												
Hydrogen	0.02	0.07	0.12	0.09	0.03	0.09	0.14	0.19	0.04	0.11	0.20	0.24
H2 - C2	2.86	2.35	2.44	2.41	2.81	2.70	2.85	2.56	3.07	3.25	3.31	3.10
C3C4	18.64	15.07	14.04	12.77	18.97	16.42	15.35	13.00	19.51	17.74	16.12	14.20
C5 + Gasoline	50.90	52.49	51.13	47.94	50.13	51.32	49.88	46.70	49.32	49.38	47.22	44.02
C6 + Gasoline	41.75	44.22	43.61	41.19	40.96	42.63	41.73	39.66	39.77	40.16	39.03	36.61
Light Cycle Oil	13.16	15.34	16.42	17.25	13.14	14.54	15.22	16.27	12.19	12.53	13.73	15.49
Decant Oil	4.20	5.70	5.68	7.66	4.16	4.89	5.49	7.94	4.22	4.27	5.45	9.31
Coke	10.47	9.06	10.31	11.95	10.77	10.11	11.21	13.53	11.68	12.82	14.15	13.90
Conversion	82.64	78.96	77.90	75.09	82.70	80.56	79.29	75.79	83.59	83.19	80.82	75.20
REACTOR EFFLUENT GAS (REG %FF)												
Hydrogen	0.02	0.07	0.12	0.09	0.03	0.09	0.14	0.19	0.04	0.11	0.20	0.24
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.52	0.49	0.51	0.53	0.52	0.53	0.52	0.42	0.52	0.58	0.49	0.45
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.60	0.51	0.51	0.61	0.62	0.61	0.63	0.52	0.79	0.84	0.82	0.72
Ethane	0.61	0.52	0.50	0.62	0.72	0.62	0.62	0.49	0.75	0.75	0.72	0.58
Ethylene	0.92	0.68	0.62	0.77	0.96	0.77	0.73	0.61	1.00	0.88	0.79	0.68
Propane	3.29	1.94	1.74	2.38	3.57	2.38	2.10	1.71	3.73	2.90	2.37	1.77
Propene	3.15	3.31	3.16	3.34	3.05	3.34	3.29	2.89	3.06	3.23	3.30	3.34
i-Butane	8.13	6.09	5.68	6.91	8.38	6.91	6.38	5.37	8.60	7.75	6.83	5.54
n-Butane	2.33	1.49	1.37	1.87	2.45	1.87	1.67	1.33	2.61	2.27	1.84	1.37
1-Butene	0.66	0.75	0.78	0.72	0.56	0.72	0.79	0.80	0.62	0.74	0.89	1.10
2-Methylpropene	0.11	0.12	0.13	0.12	0.09	0.12	0.13	0.13	0.10	0.12	0.14	0.18
trans-2-Butene	0.73	0.80	0.86	0.81	0.66	0.81	0.86	0.85	0.62	0.76	0.85	0.93
cis-2-Butene	0.51	0.57	0.59	0.56	0.45	0.56	0.61	0.62	0.43	0.53	0.61	0.67
i-Pentane	5.45	4.21	4.16	5.13	5.53	5.13	5.05	4.43	6.01	6.46	5.72	4.70
n-Pentane	0.39	0.28	0.28	0.34	0.40	0.34	0.36	0.35	0.41	0.47	0.44	0.38
1-Pentene	0.00	0.04	0.04	0.04	0.01	0.04	0.09	0.07	0.04	0.04	0.04	0.06
2-Methyl-1-Butene	0.00	0.00	0.00	0.08	0.12	0.08	0.12	0.11	0.05	0.00	0.09	0.00
trans-2-Pentene	0.08	0.18	0.09	0.08	0.00	0.08	0.10	0.16	0.02	0.16	0.10	0.30
cis-2-Pentene	0.00	0.14	0.16	0.10	0.00	0.10	0.13	0.16	0.00	0.09	0.09	0.19
2-Methyl-2-Butene	0.16	0.00	0.00	0.17	0.00	0.17	0.17	0.25	0.11	0.12	0.16	0.26
C6+	1.67	1.50	1.53	1.79	1.57	1.79	1.92	1.83	1.79	2.25	2.30	2.23

Table 3.9.4
The Effects of Metals Impregnation on Catalyst Cracking
Blend B - Corroborative Runs

Contact Time :	60 s							120 s		200 s			
Metals : Nickel ppm:	0	500	1000	2000	0	0	0	0	2000	0	500	1000	2000
Vanadium ppm:	0	0	0	0	500	1000	2000	0	0	0	500	1000	2000
MICROACTIVITY TEST-Yield Stuctures mass %FF													
PRODUCTS													
H2 - C2 :	1.36	1.19	1.21	1.15	1.20	1.46	1.18	1.81	1.69	2.07	1.94	2.01	2.20
C3C4 :	28.13	24.77	26.32	21.77	26.05	26.42	24.55	30.70	25.50	31.75	27.87	26.57	24.54
C5'S :	13.92	12.78	13.56	11.61	13.22	12.42	12.87	14.28	13.39	14.56	14.76	13.51	12.53
C5 + Gasoline :	55.28	57.08	57.00	58.39	57.70	57.17	58.56	52.41	56.34	50.06	53.71	54.24	53.25
C6 + Gasoline :	41.36	44.30	43.44	46.78	44.48	43.59	45.69	38.13	42.95	35.50	38.95	40.73	40.72
Light Cycle Oil :	7.90	8.90	8.36	10.17	8.46	7.94	8.91	6.84	7.63	6.61	7.29	7.71	8.66
Decant Oil :	1.06	1.56	1.39	1.90	1.45	1.29	1.54	0.54	1.25	1.04	1.42	1.42	1.59
Coke :	6.27	6.48	5.72	6.82	5.12	5.72	5.25	7.29	7.59	9.47	7.77	8.07	9.76
Conversion :	91.04	89.54	90.24	87.93	90.09	90.77	89.55	92.21	91.11	92.35	91.29	90.85	89.75
REACTOR EFFLUENT GAS (REG %FF)													
Hydrogen :	0.02	0.08	0.04	0.15	0.03	0.04	0.04	0.03	0.17	0.04	0.10	0.14	0.22
Carbon Monoxide :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane :	0.30	0.23	0.27	0.19	0.32	0.28	0.30	0.42	0.37	0.55	0.55	0.58	0.52
Ethane :	0.35	0.27	0.29	0.19	0.31	0.28	0.33	0.49	0.32	0.58	0.53	0.54	0.52
Ethylene :	0.68	0.53	0.58	0.39	0.53	0.38	0.47	0.86	0.56	0.89	0.68	0.60	0.58
Propane :	3.71	2.81	3.10	1.84	2.92	2.16	2.52	4.80	2.65	5.48	3.82	3.41	3.45
Propene :	4.21	4.15	4.21	4.18	4.39	4.55	4.28	4.04	4.50	3.74	4.25	4.28	3.85
i-Butane :	14.82	12.90	13.65	11.17	13.37	11.34	12.72	16.35	13.29	17.05	14.62	13.78	12.74
n-Butane :	2.94	2.26	2.58	1.57	2.35	1.69	2.12	3.46	2.17	3.87	2.92	2.55	2.41
1-Butene :	0.90	0.98	1.01	1.18	1.00	1.13	1.02	0.77	1.09	0.71	0.87	0.99	0.86
2-Methylpropene :	0.15	0.16	0.17	0.19	0.16	0.18	0.17	0.13	0.18	0.12	0.14	0.16	0.14
trans-2-Butene :	0.87	0.94	1.00	1.08	1.02	1.07	0.99	0.70	1.05	0.63	0.83	0.91	0.77
cis-2-Butene :	0.62	0.66	0.72	0.77	0.72	0.76	0.70	0.49	0.74	0.44	0.59	0.65	0.52
i-Pentane :	8.49	7.40	8.30	6.63	7.43	5.73	7.19	8.49	7.99	9.55	8.66	8.17	6.86
n-Pentane :	0.48	0.42	0.49	0.38	0.41	0.28	0.42	0.48	0.47	0.59	0.51	0.48	0.39
1-Pentene :	0.02	0.02	0.02	0.06	0.02	0.04	0.03	0.02	0.02	0.07	0.07	0.04	0.01
2-Methyl-1-Butene :	0.18	0.09	0.17	0.11	0.20	0.09	0.07	0.06	0.11	0.07	0.16	0.00	0.08
trans-2-Pentene :	0.00	0.07	0.00	0.10	0.00	0.08	0.09	0.06	0.12	0.00	0.11	0.14	0.04
cis-2-Pentene :	0.08	0.10	0.11	0.11	0.00	0.13	0.15	0.06	0.00	0.05	0.16	0.08	0.07
2-Methyl-2-Butene :	0.18	0.15	0.20	0.22	0.10	0.19	0.20	0.10	0.19	0.14	0.15	0.14	0.21
C6+ :	2.20	1.99	2.07	2.14	2.06	1.63	1.99	1.88	2.46	2.34	2.49	2.45	1.87

Table 3.9.5
The Effects of Metals Impregnation on Catalyst Cracking
Typical VGO Feedstock

Contact Time :	60 s							120 s		
Metals : Nickel ppm:	0	500	1000	2000	0	0	0	0	2000	0
Vanadium ppm:	0	0	0	0	500	1000	2000	0	0	2000
MICROACTIVITY TEST-Yield Stuctures mass %FF										
PRODUCTS										
H2 - C2	2.66	2.98	2.70	2.73	2.61	2.85	2.77	2.81	3.24	3.26
C3C4	18.64	17.75	17.14	15.06	17.35	16.56	16.32	18.97	16.61	17.86
C5'S	9.15	8.86	8.60	8.34	9.01	7.91	8.59	9.17	8.40	9.14
C5 + Gasoline	50.90	48.18	48.92	48.93	51.53	50.31	51.61	50.13	47.10	50.02
C6 + Gasoline	41.75	39.30	40.32	40.64	42.52	41.55	43.02	40.96	38.70	40.88
Light Cycle Oil	13.16	13.53	14.18	14.48	13.58	13.86	14.35	13.14	13.34	12.99
Decant Oil	4.20	5.05	5.42	5.35	4.26	4.14	4.39	4.16	4.99	4.02
Coke	10.47	12.54	11.63	13.40	10.67	12.68	14.55	10.77	14.74	11.85
Conversion	82.64	81.42	80.40	80.17	82.16	82.20	81.26	82.70	81.67	82.99
REACTOR EFFLUENT GAS (REG %FF)										
Hydrogen	0.02	0.14	0.10	0.18	0.04	0.06	0.08	0.03	0.22	0.10
Carbon Monoxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydogen Sulfide	0.52	0.51	0.45	0.46	0.51	0.51	0.54	0.52	0.46	0.59
Carbon Dioxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane	0.60	0.65	0.63	0.53	0.63	0.61	0.68	0.62	0.69	0.84
Ethane	0.61	0.57	0.58	0.49	0.61	0.52	0.66	0.72	0.63	0.80
Ethylene	0.92	0.90	0.85	0.75	0.83	0.58	0.77	0.96	0.87	0.86
Propane	3.29	2.85	2.62	1.95	2.97	1.49	2.36	3.57	2.32	2.97
Propene	3.15	3.25	3.28	3.21	2.98	3.75	3.23	3.05	3.44	3.23
i-Butane	8.13	7.78	7.34	6.46	7.60	5.60	6.89	8.38	7.13	7.73
n-Butane	2.33	2.15	2.02	1.62	2.22	1.21	1.94	2.45	1.84	2.29
1-Butene	0.66	0.82	0.82	0.87	0.67	1.16	0.79	0.56	0.95	0.74
2-Methylpropene	0.11	0.13	0.13	0.14	0.11	0.19	0.13	0.09	0.15	0.12
trans-2-Butene	0.73	0.80	0.81	0.88	0.66	1.09	0.81	0.66	0.92	0.75
cis-2-Butene	0.51	0.57	0.57	0.63	0.46	0.75	0.57	0.45	0.66	0.52
i-Pentane	5.45	6.06	5.51	5.59	5.52	4.21	5.48	5.53	6.20	6.14
n-Pentane	0.39	0.48	0.38	0.40	0.41	0.27	0.40	0.40	0.49	0.45
1-Pentene	0.00	0.00	0.04	0.10	0.02	0.09	0.03	0.01	0.03	0.14
2-Methyl-1-Butene	0.00	0.11	0.07	0.14	0.00	0.00	0.00	0.12	0.00	0.10
trans-2-Pentene	0.08	0.09	0.10	0.14	0.19	0.29	0.09	0.00	0.09	0.06
cis-2-Pentene	0.00	0.12	0.00	0.23	0.00	0.18	0.06	0.00	0.16	0.06
2-Methyl-2-Butene	0.16	0.15	0.12	0.27	0.17	0.23	0.11	0.00	0.24	0.12
C6+	1.67	2.06	1.86	2.30	1.71	1.73	1.89	1.57	2.63	2.09

Table 3.10.1
Fluid Catalytic Cracking Catalyst
Analytical Data

Task(s)	Catalyst *				PHYSICAL PROPERTIES							CHEMICAL PROPERTIES							
	Number	Description (DA-440)	Steam Period hrs	Thermal Period hrs	Apparent Bulk Density A.B.D. g/cc	Pore Volume P.V. cc/g	Surface Area S.A. m2/g	Average Pore Diameter A.P.D. um	Average Particle Size A.P.S. um	Percent Xtal %	Unit Cell Size U.C.S. A	Alumina Al203 %	Sodium Na %	Iron Fe %	Carbon C %	Vanadium V ppm	Nickel Ni ppm	Copper Cu ppm	Rare Earth Re2O3 %
1,2,3,4	XC0130E	Equilibrium			0.90	0.29	76	153	62	8.5	24.425	44.4	0.39	1.00	<0.01	1750	1130	137	3.94
5	XC01505.11	Fresh	5		0.87	0.29	106	109	84	10.2	24.660	43.5	0.16	0.65	0.11	81	<150	13	4.50
	XC01505.27	Fresh	5		0.87	0.29	106	109	84	10.2	24.660	43.5	0.16	0.65	0.27	81	<150	15	4.50
	XC01505.48	Fresh	5		0.87	0.29	106	109	84	10.2	24.660	43.5	0.16	0.65	0.48	81	<150	13	4.50
6	XC01705	Fresh	4				117			10.6	24.680	43.5	0.15	0.56	<0.01	80	102	14	
	XC01905	Fresh	8		0.85	0.33	110	120	84	9.4	24.650	43.5	0.12	0.47	<0.01	63	85	16	4.50
	XC01605	Fresh	16		0.87	0.29	109	106	86	9.5	24.640	43.3	0.18	0.65	<0.01	74	95	12	4.54
	XC01805	Fresh	32		0.86	0.28	101	111	82	9.2	24.610	43.6	0.15	0.48	<0.01	62	157	13	4.53
	XC0330T	Fresh		** 8						N.D.	N.D.				<0.01				
	XC0340T	Fresh		** 16						N.D.	N.D.				<0.01				
	XC0350T	Fresh		** 32						N.D.	N.D.				<0.01				
	XC0360T	Fresh		1						12.8	24.652				<0.01				
	XC0370T	Fresh		2						12.5	24.651				<0.01				
	XC0380T	Fresh		4	0.85	0.33	135	98	50	12.4	24.635	45.5	0.29	0.62	<0.01	157	46	<20	3.55
	XC0390T	Fresh		8	0.84	0.33	133	39	49	11.3	24.618	45.5	0.31	0.62	<0.01	156	44	<20	3.57
	XC0400T	Fresh		16	0.84	0.32	125	102	50	10.3	24.650	45.8	0.31	0.62	<0.01	149	44	<20	3.57
7	XC0410H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.0	0.17	0.62	<0.01	491	64	<20	4.48
	XC0420H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.6	0.17	0.62	<0.01	990	55	<20	4.54
	XC0430H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	43.4	0.17	0.62	<0.01	1875	72	<20	4.40
	XC0440H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.1	0.17	0.62	<0.01	80	567	<20	4.51
	XC0450H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.1	0.17	0.62	<0.01	80	980	<20	4.47
	XC0460H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.5	0.17	0.62	<0.01	80	1960	<20	4.45
	XC0470H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.3	0.17	0.62	<0.01	489	549	<20	4.54
	XC0480H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.3	0.17	0.62	<0.01	988	1155	<20	4.49
	XC0490H	Fresh	5	*** 1	0.86	0.29	106	109	85	9.9	24.650	44.0	0.17	0.62	<0.01	1986	2057	<20	4.47
8	XC0140F	Fresh								14.1	24.724		0.25	0.44	<0.01	140	122	32	4.62

NOTES

* Two types of DA-440 catalyst were used. The equilibrium material is from a full riser catalytic cracking unit while the fresh material was obtained directly from Davison. Catalyst steaming was performed at a temperature of 732 C, 100% steam at 5 psi. Thermal deactivation was carried out at 860 C unless otherwise noted.

** Thermal deactivation was carried out at 899 C.

*** As specified in the preparation, cf. section 2.3.

FIGURES

Figure 2.1.1 Microactivity Test Unit

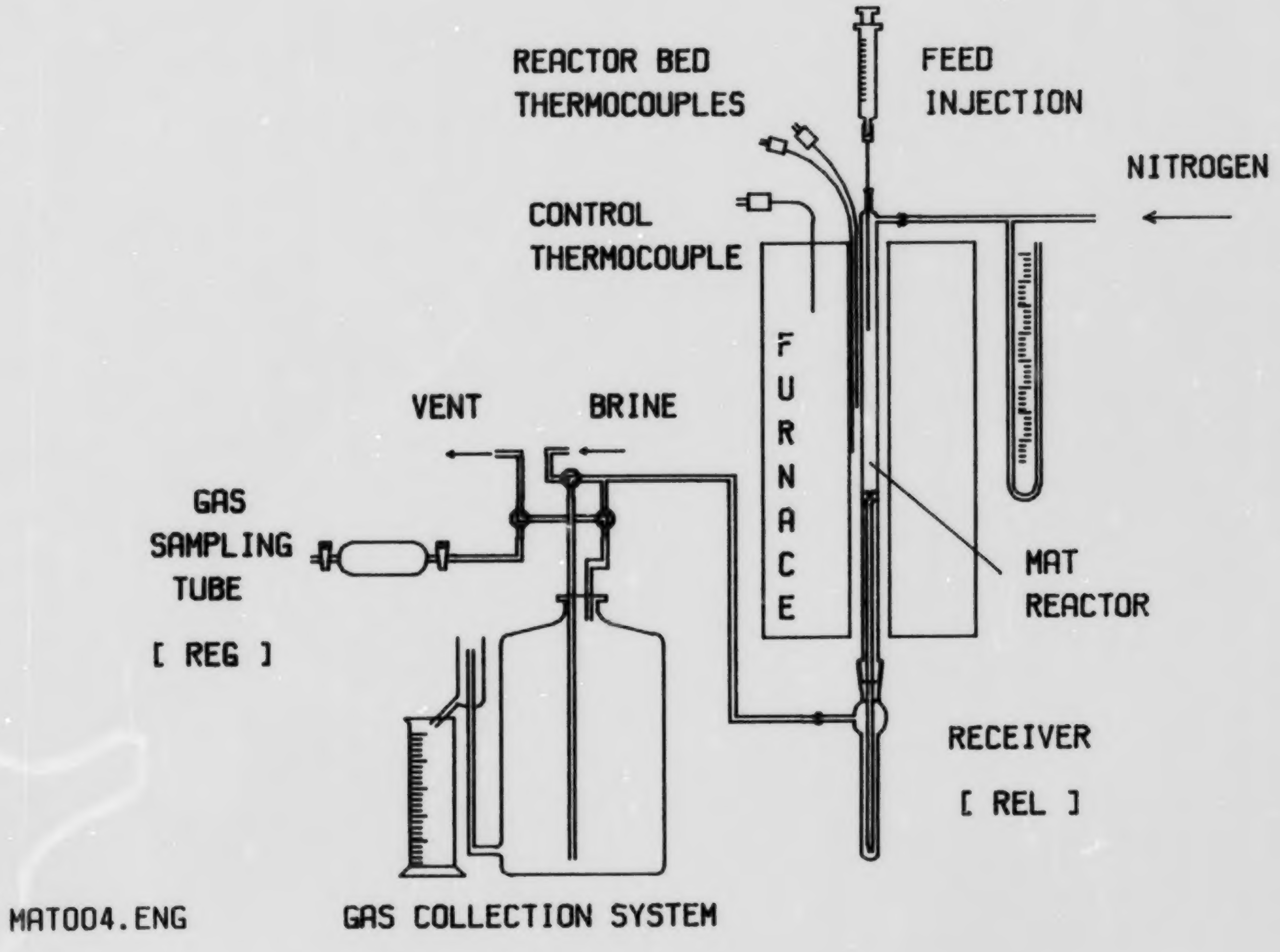


Figure 2.3.1

CATALYST STEAMER

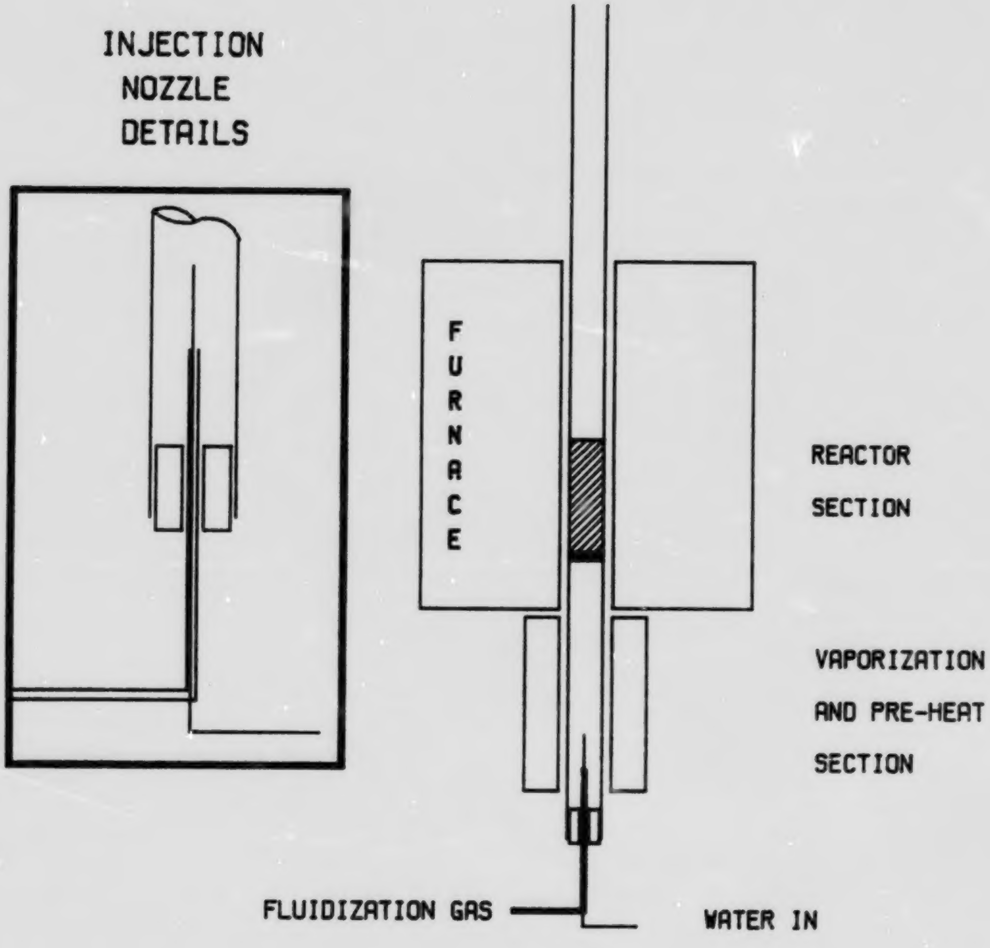


Figure 3.2.1 n-Octadecane Conversion

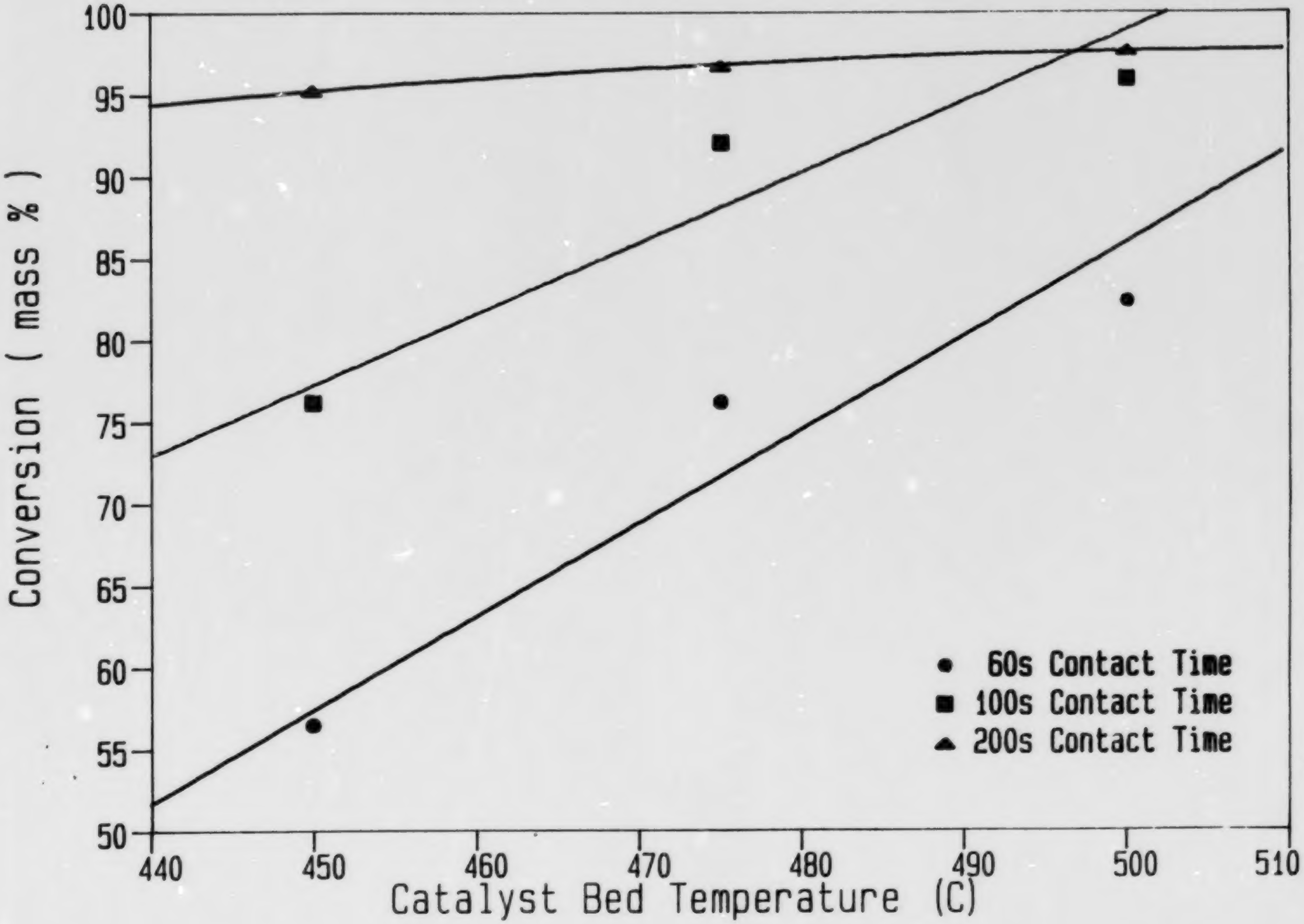


Figure 3.2.2 n-Octadecane C3C4 Yields

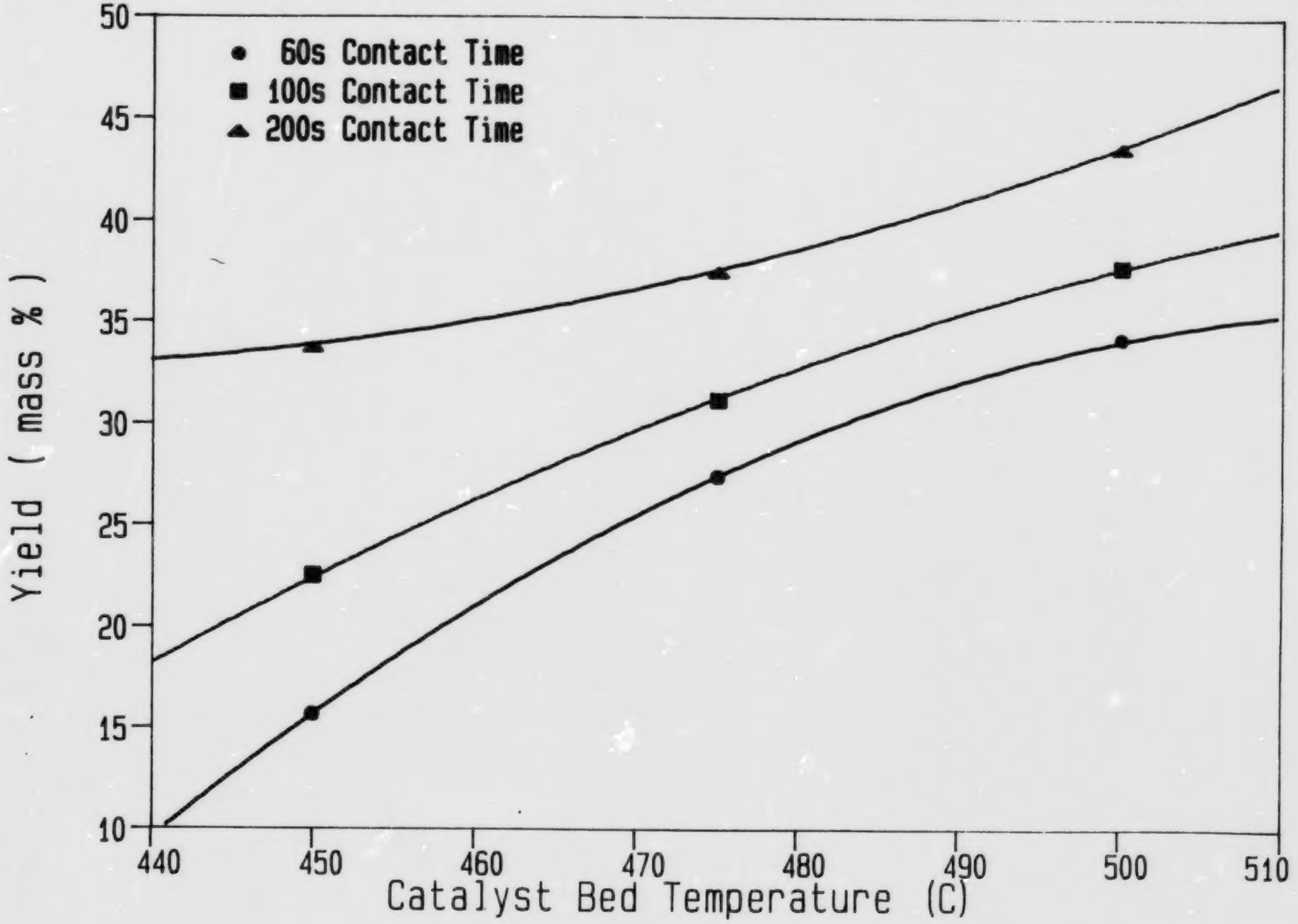


Figure 3.2.3 n-Octadecane C5+Gasoline Yields

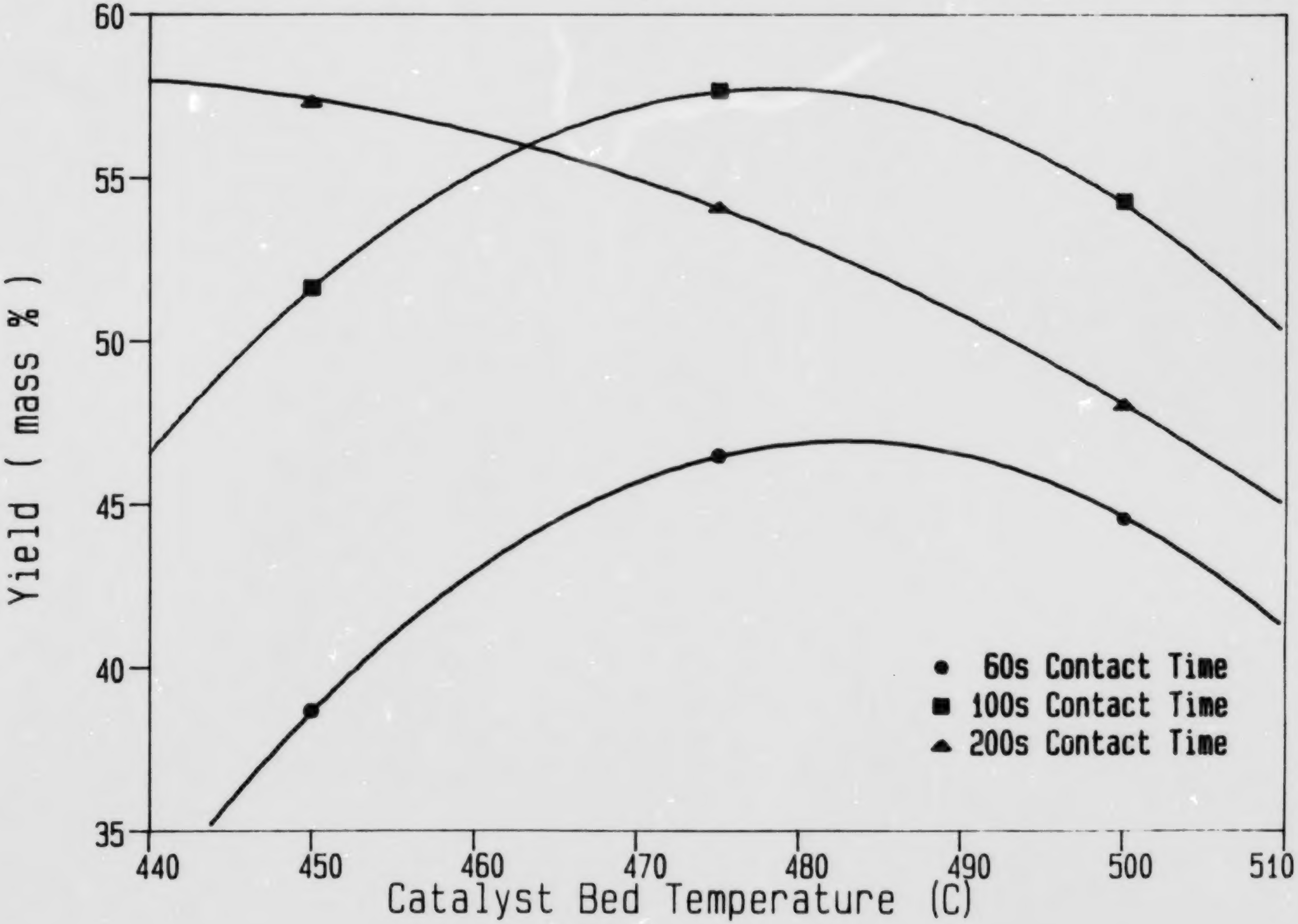


Figure 3.2.4 n-Octadecane LCO Yields

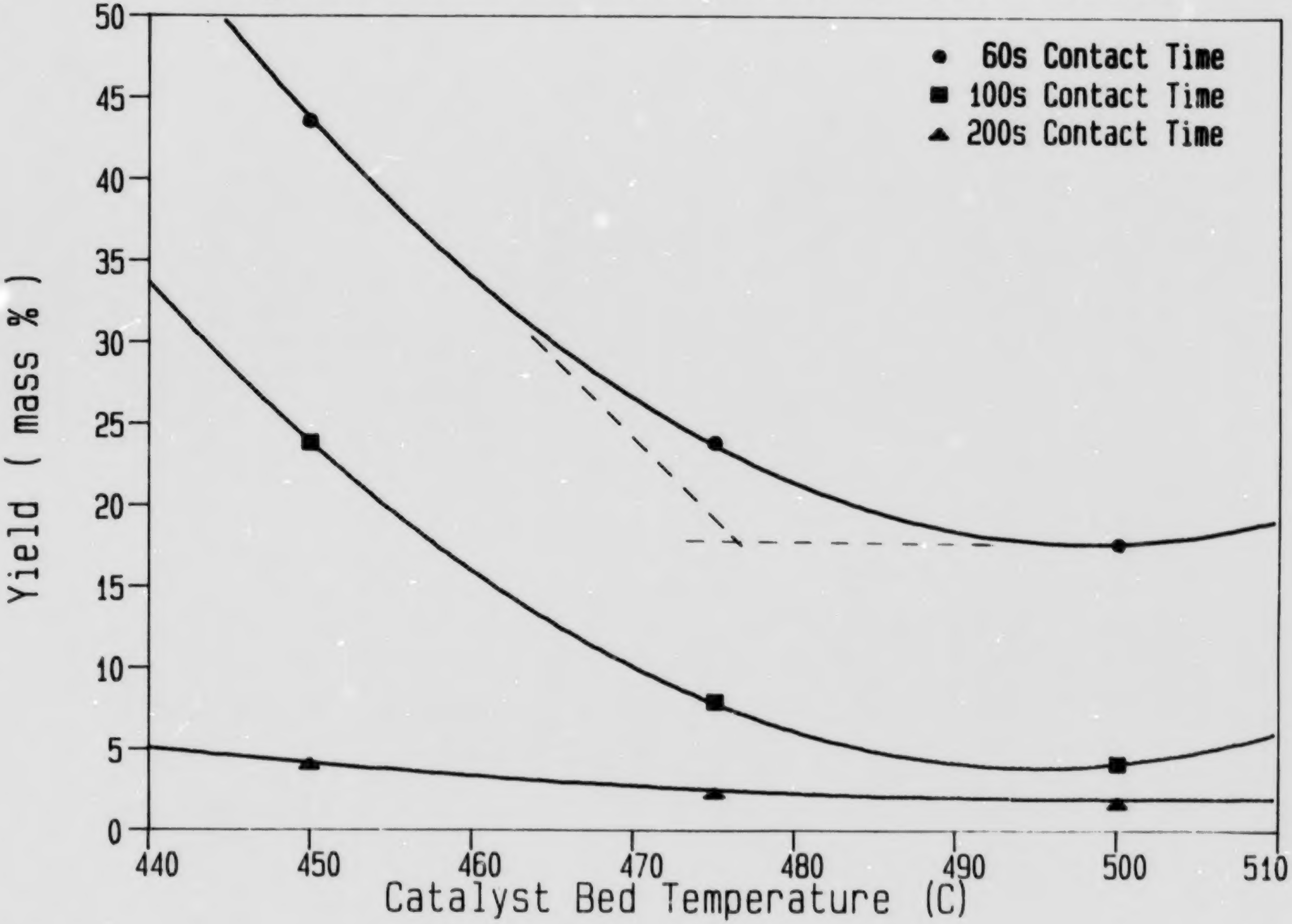


Figure 3.2.5 n-Octadecane Coke Yields

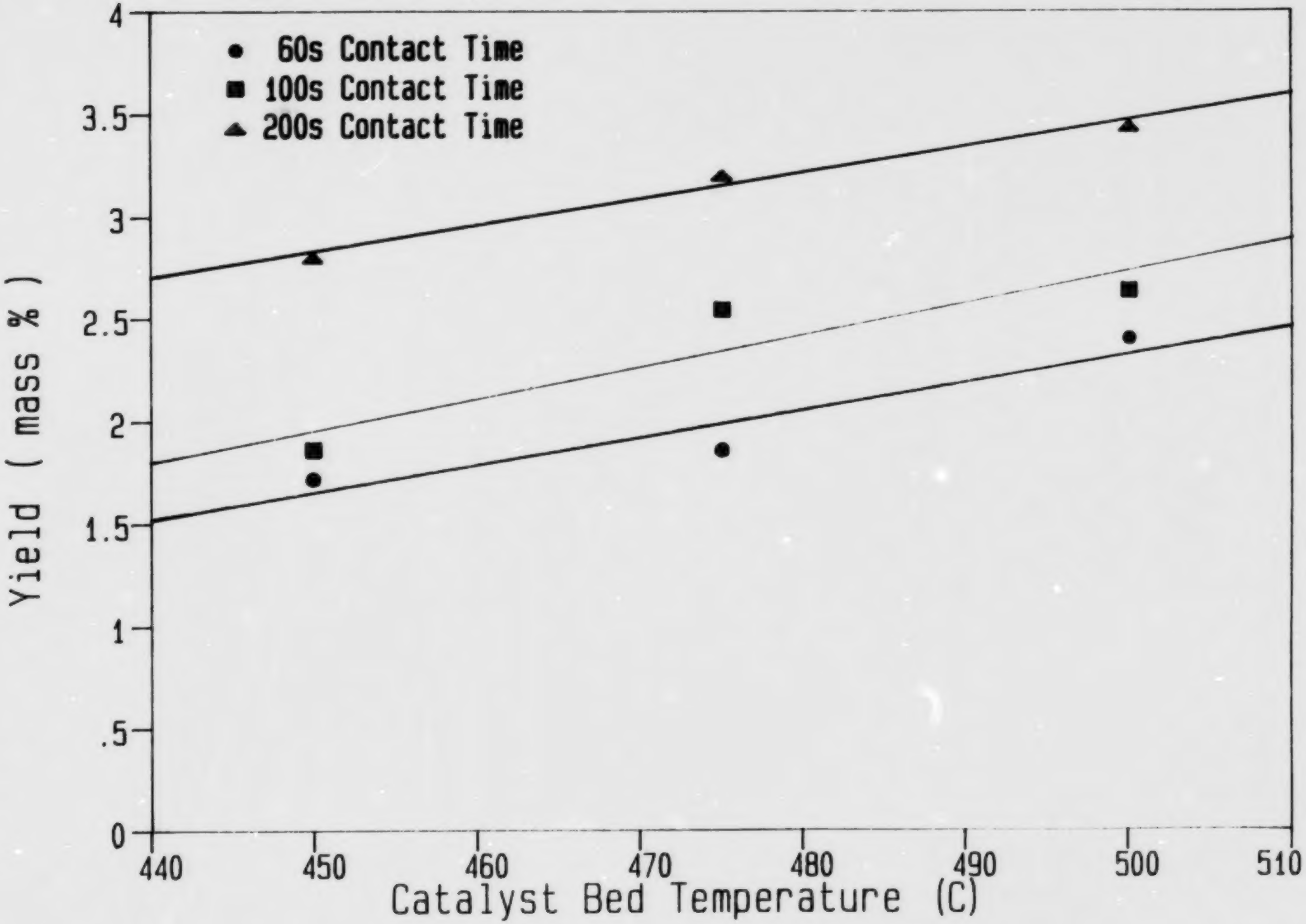


Figure 3.2.6 n-Hexacosane Conversion

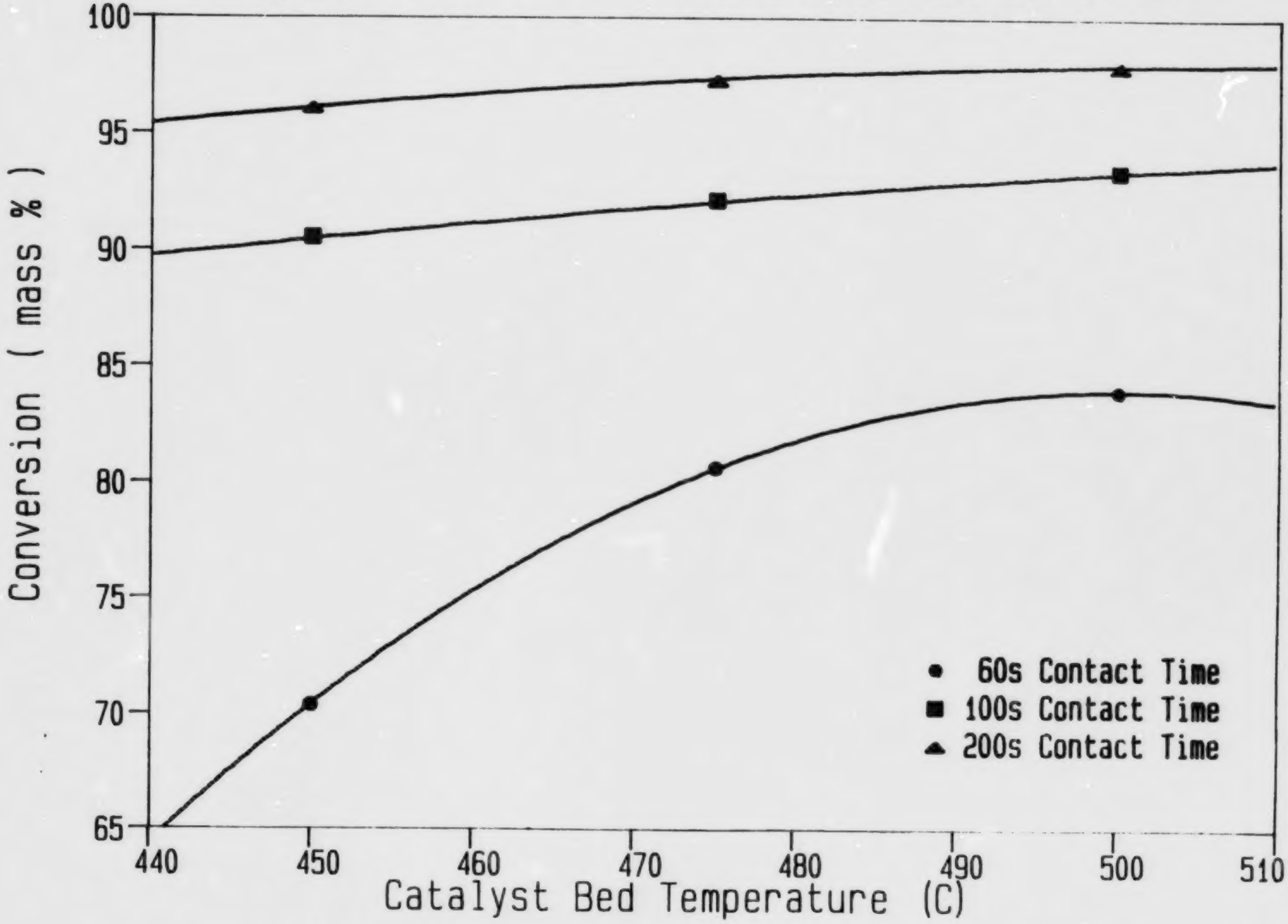


Figure 3.2.7 n-Hexacosane C5+Gasoline Yields

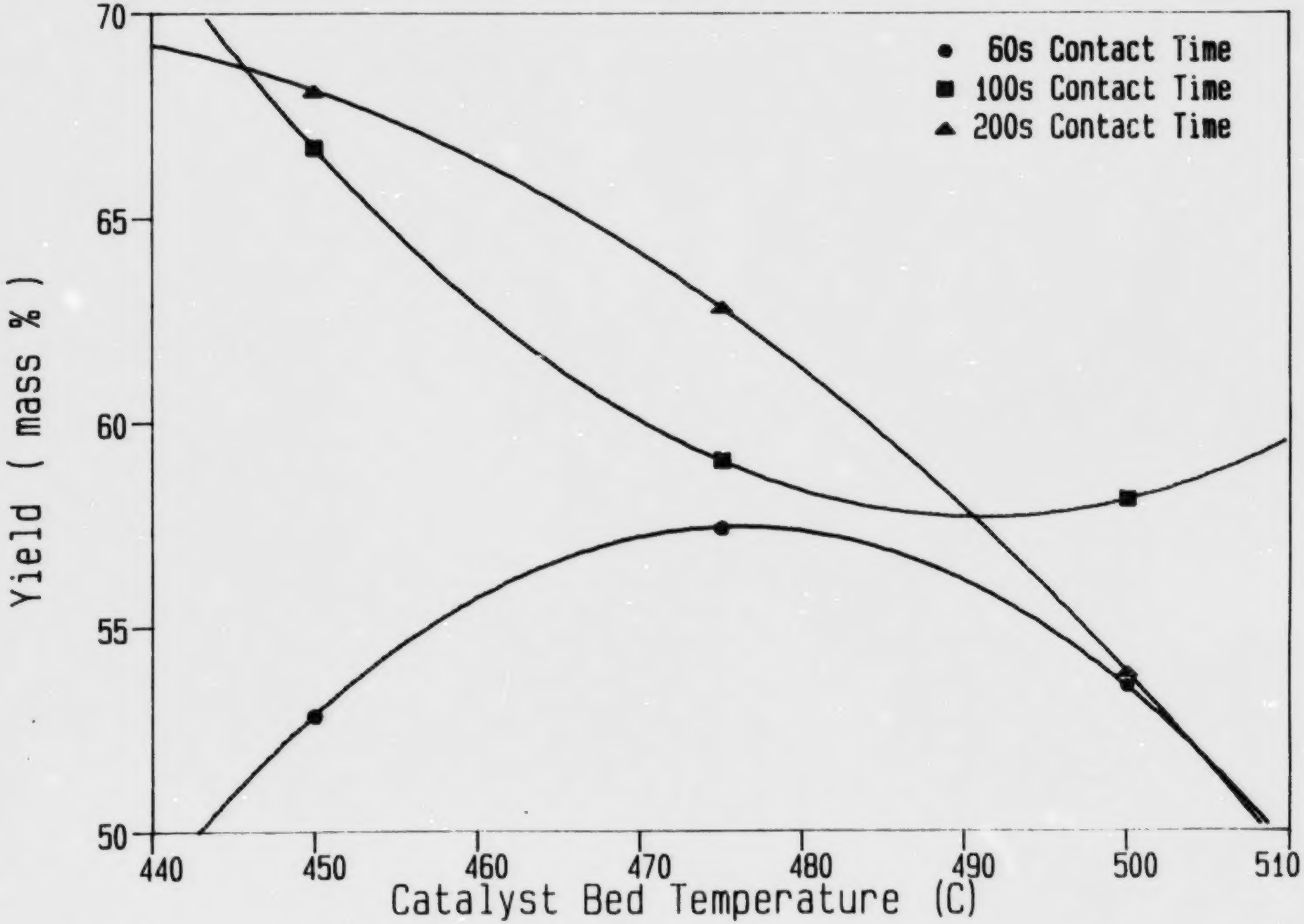
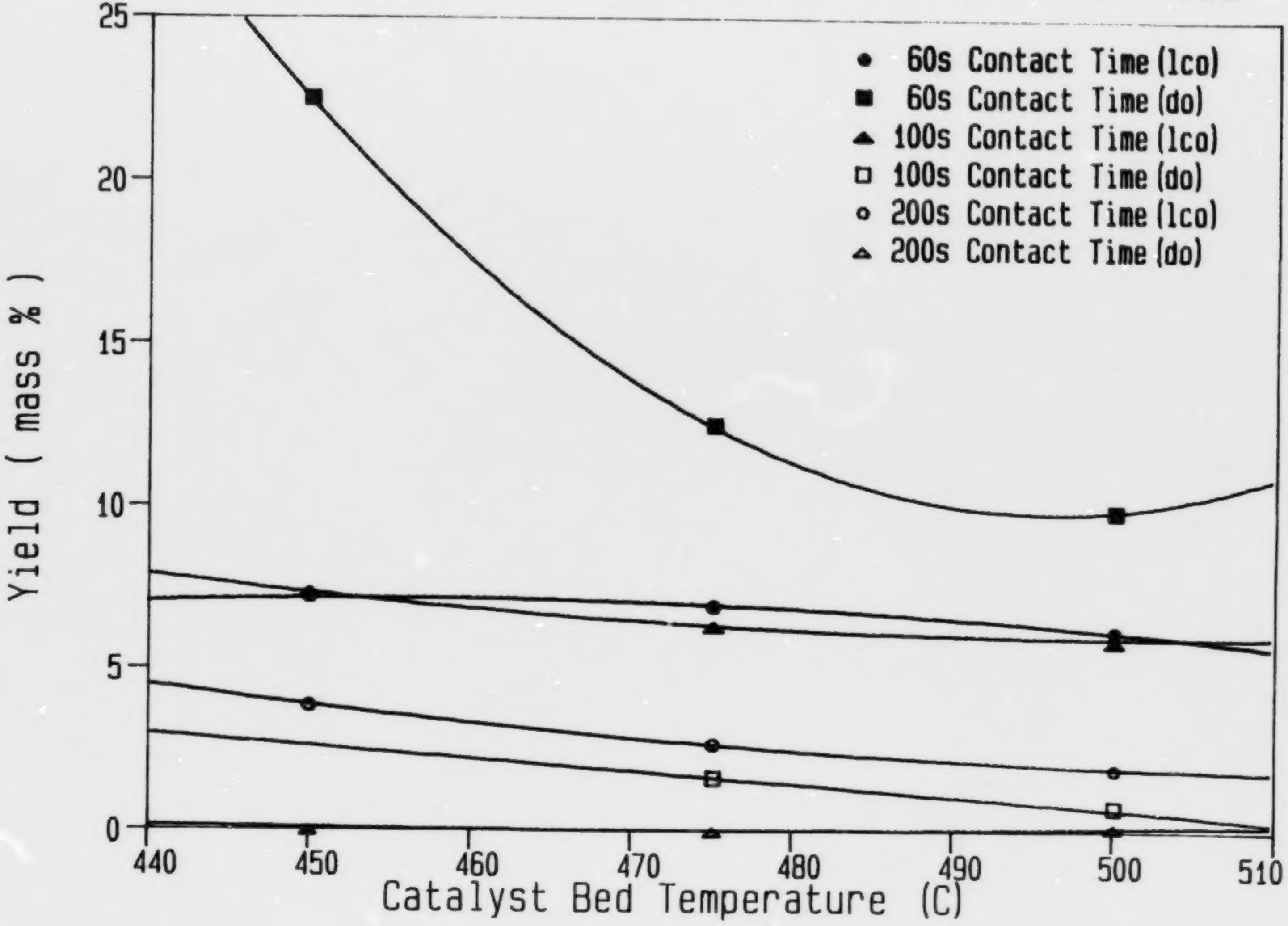


Figure 3.2.8 n-Hexacosane LCO & DO Yields



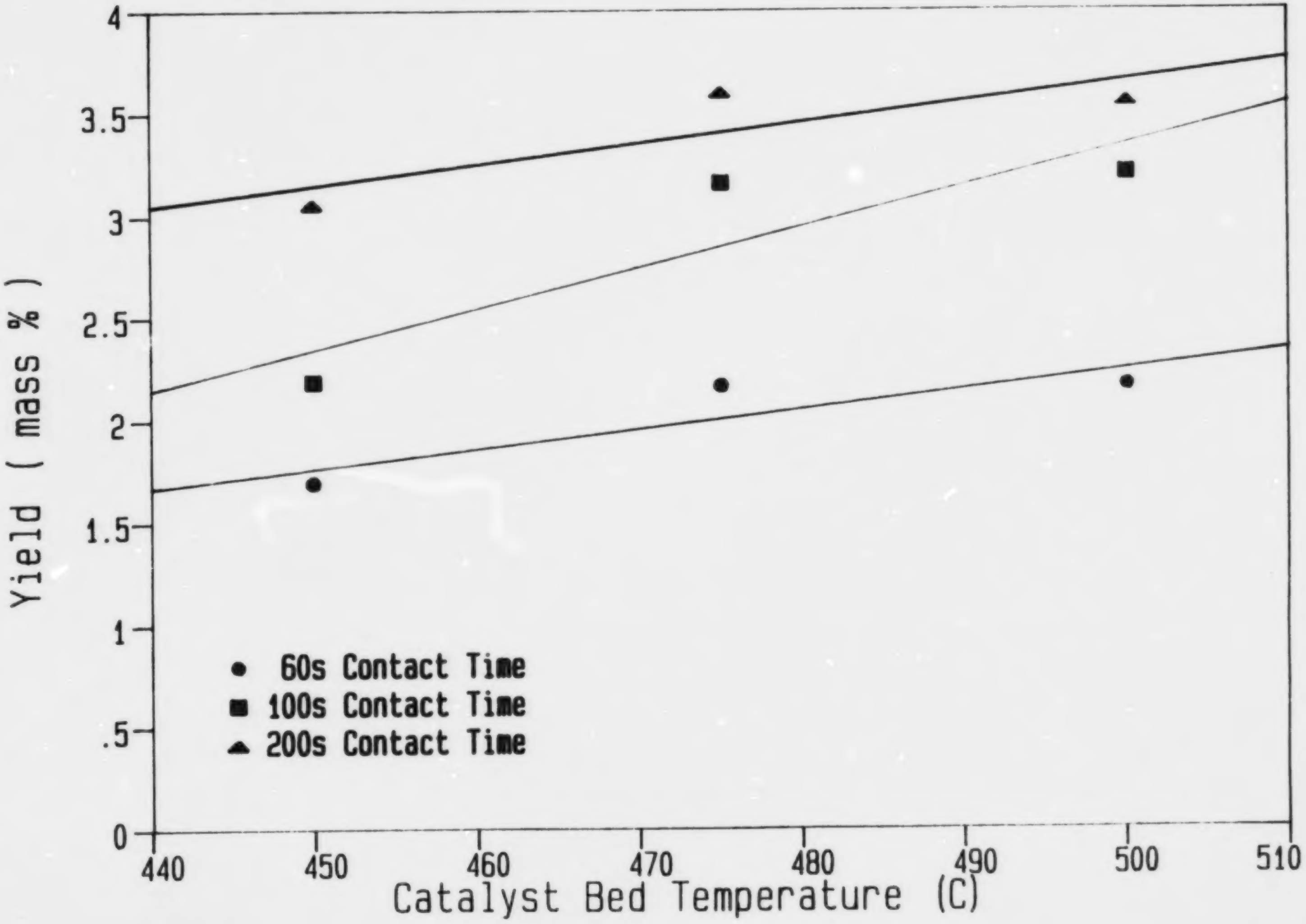


Figure 3.2.9 n-Hexacosane Coke Yields

Figure 3.2.10 n-Dotriacontane Conversion

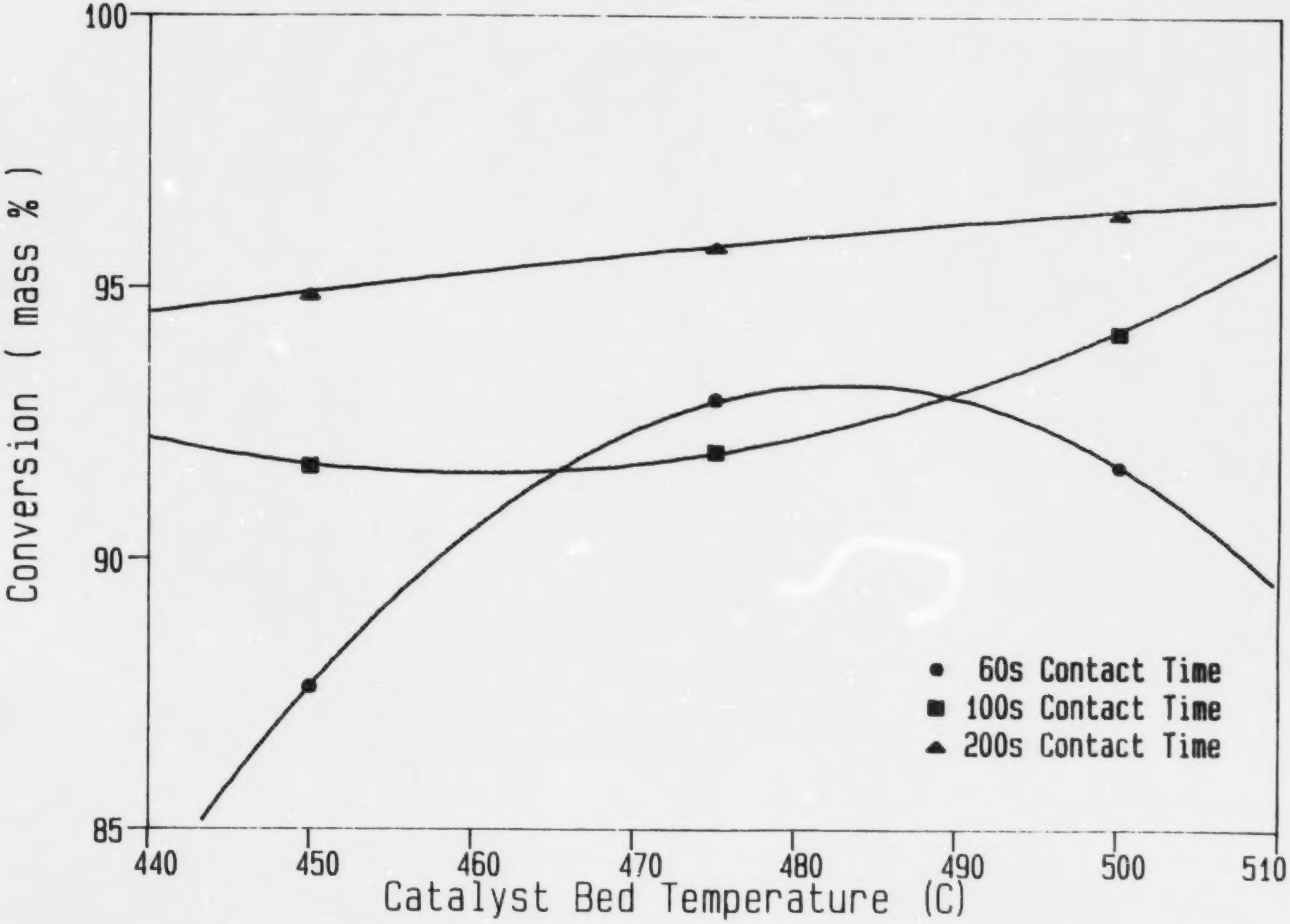


Figure 3.2.11 n-Dotriacontane C5+Gasoline Yields

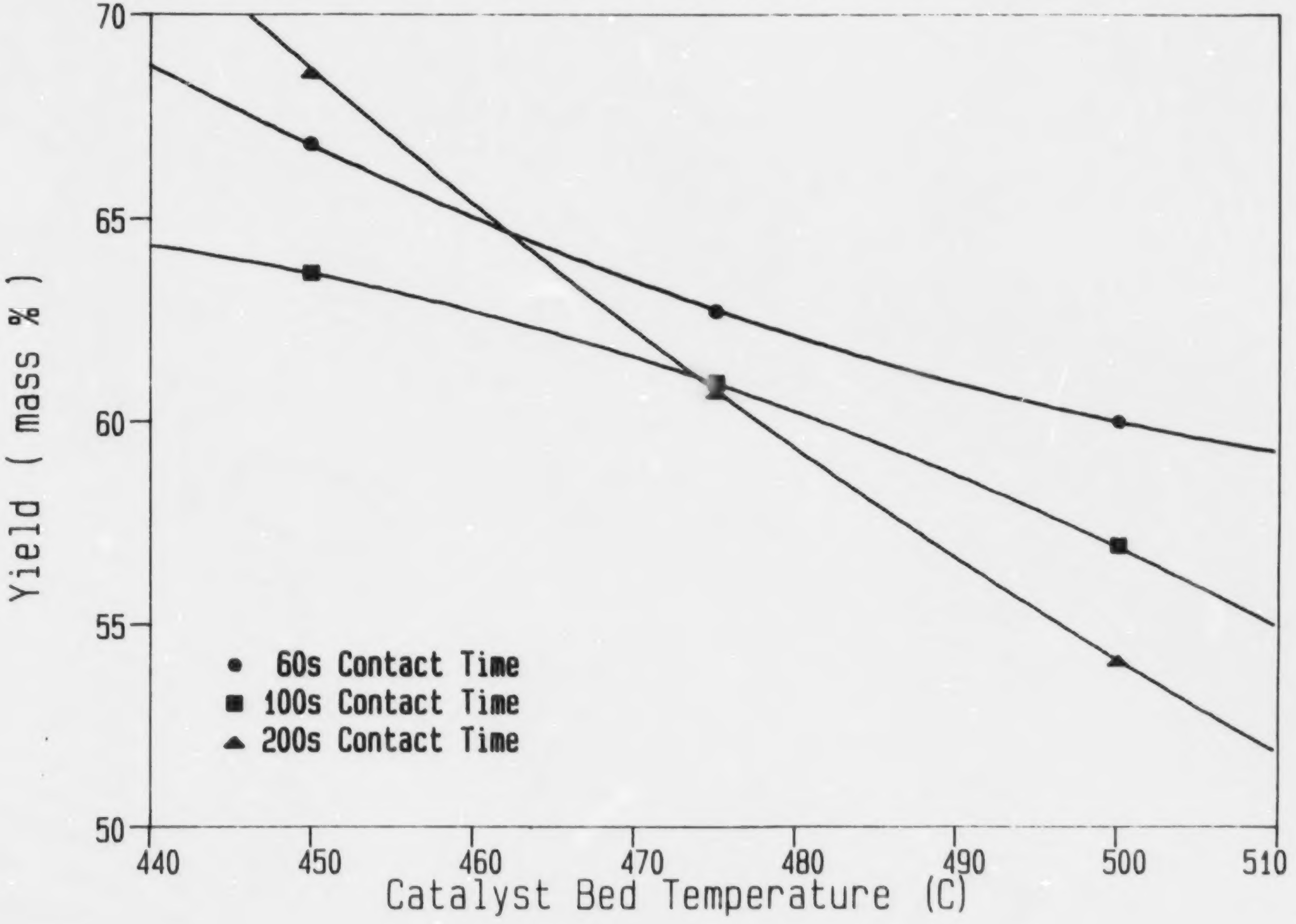


Figure 3.2.12 n-Dotriacontane LCO & DO Yields

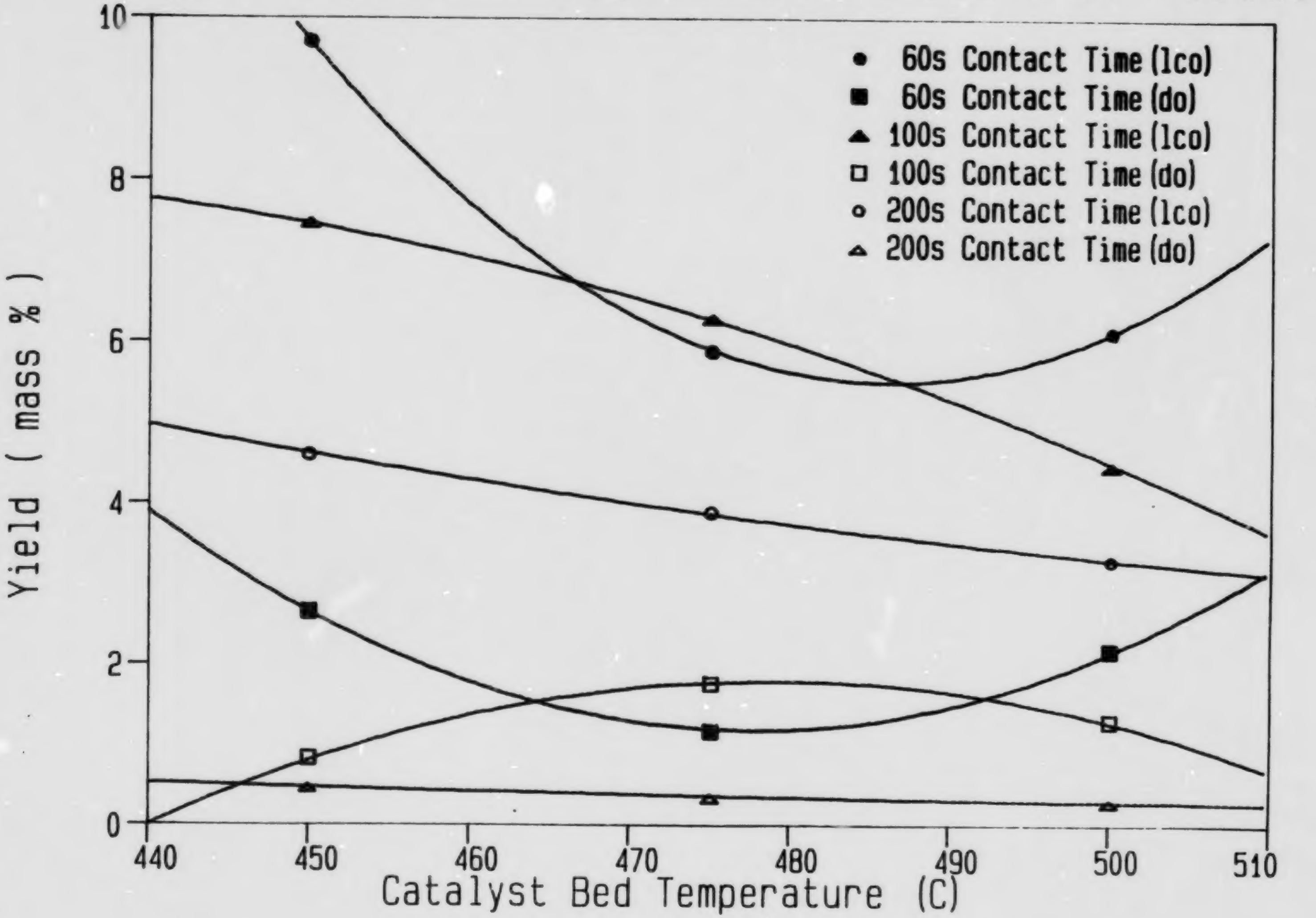


Figure 3.2.13 n-Dotriacontane Coke Yields

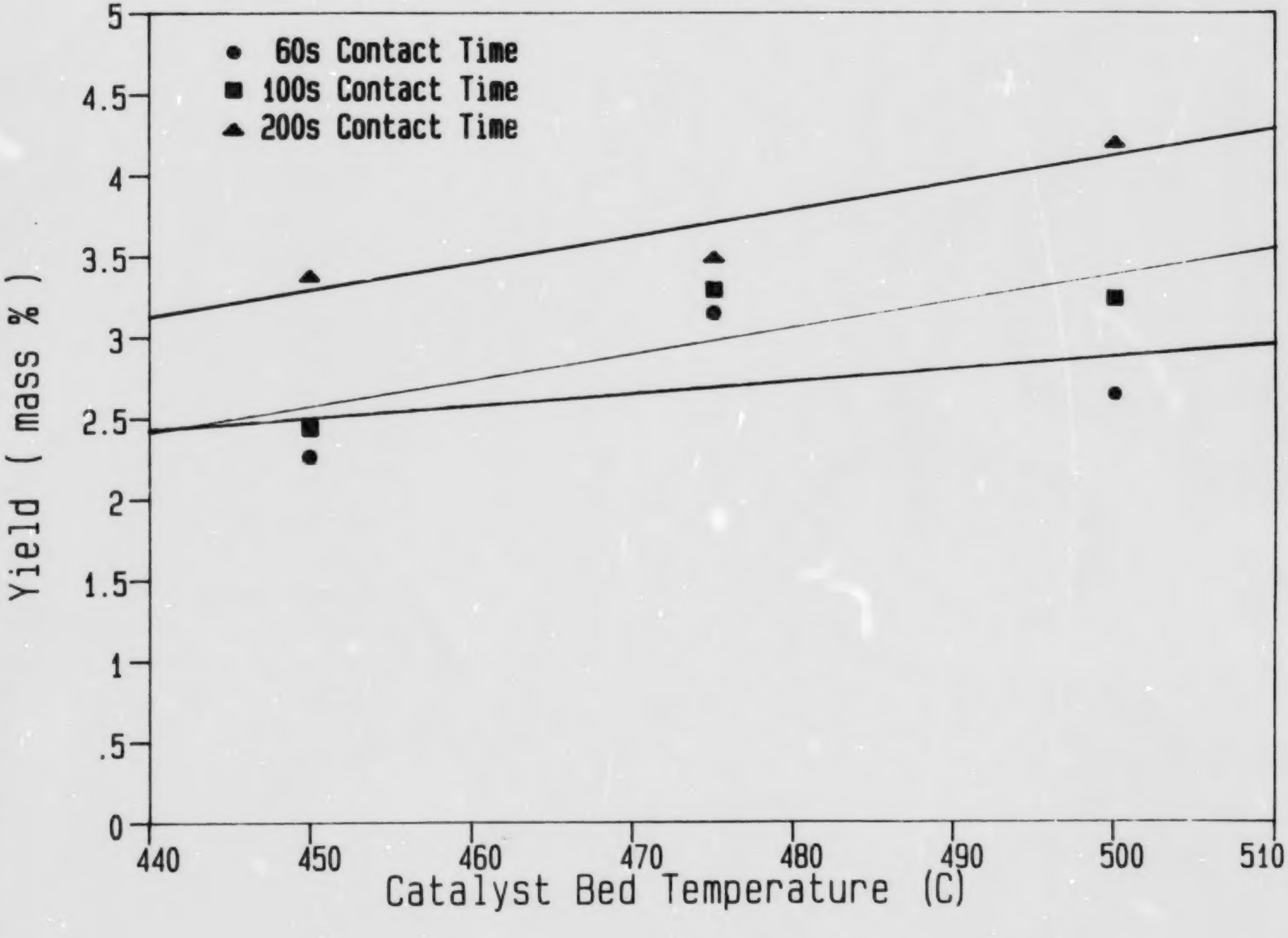


Figure 3.2.14 Effects of Feed Molecular Weight

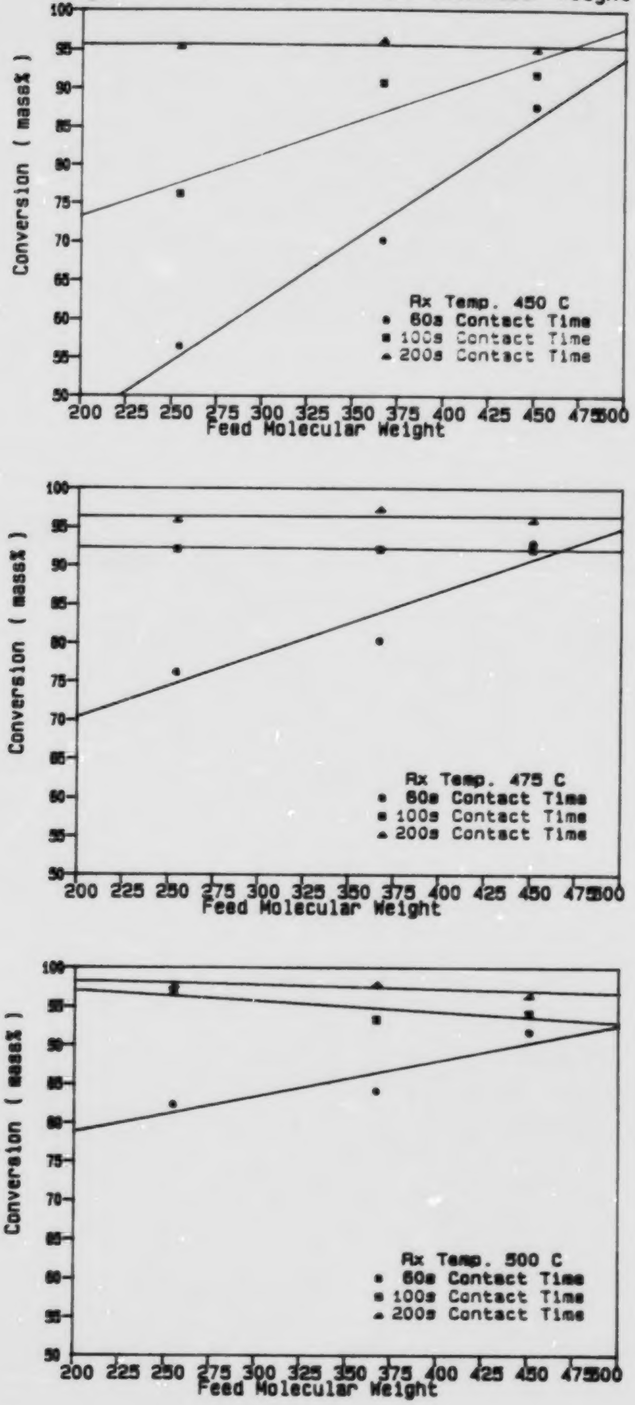


Figure 3.2.15 n-Octadecane C5+Gasoline Yields

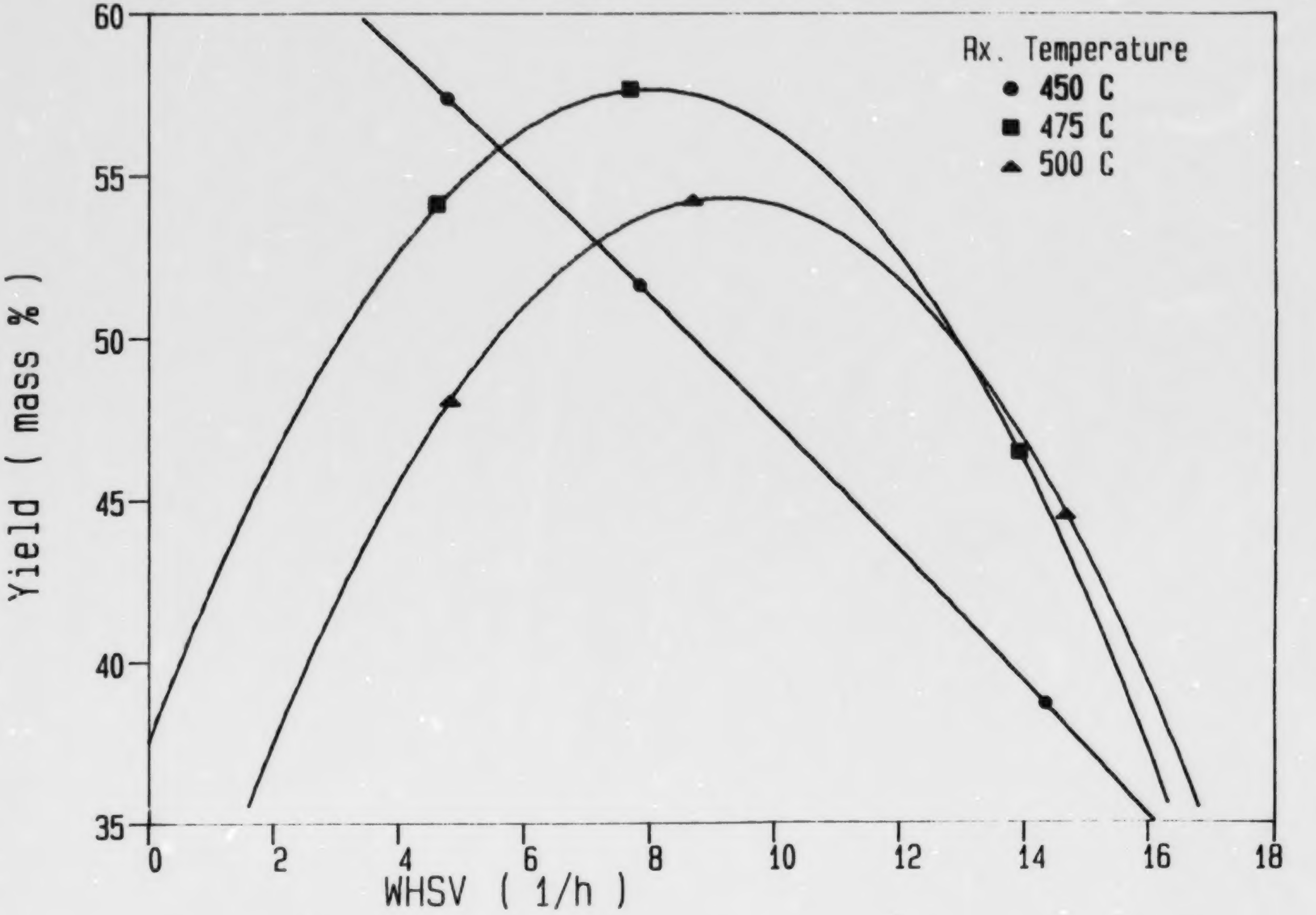


Figure 5.2.16

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION

Octadecane

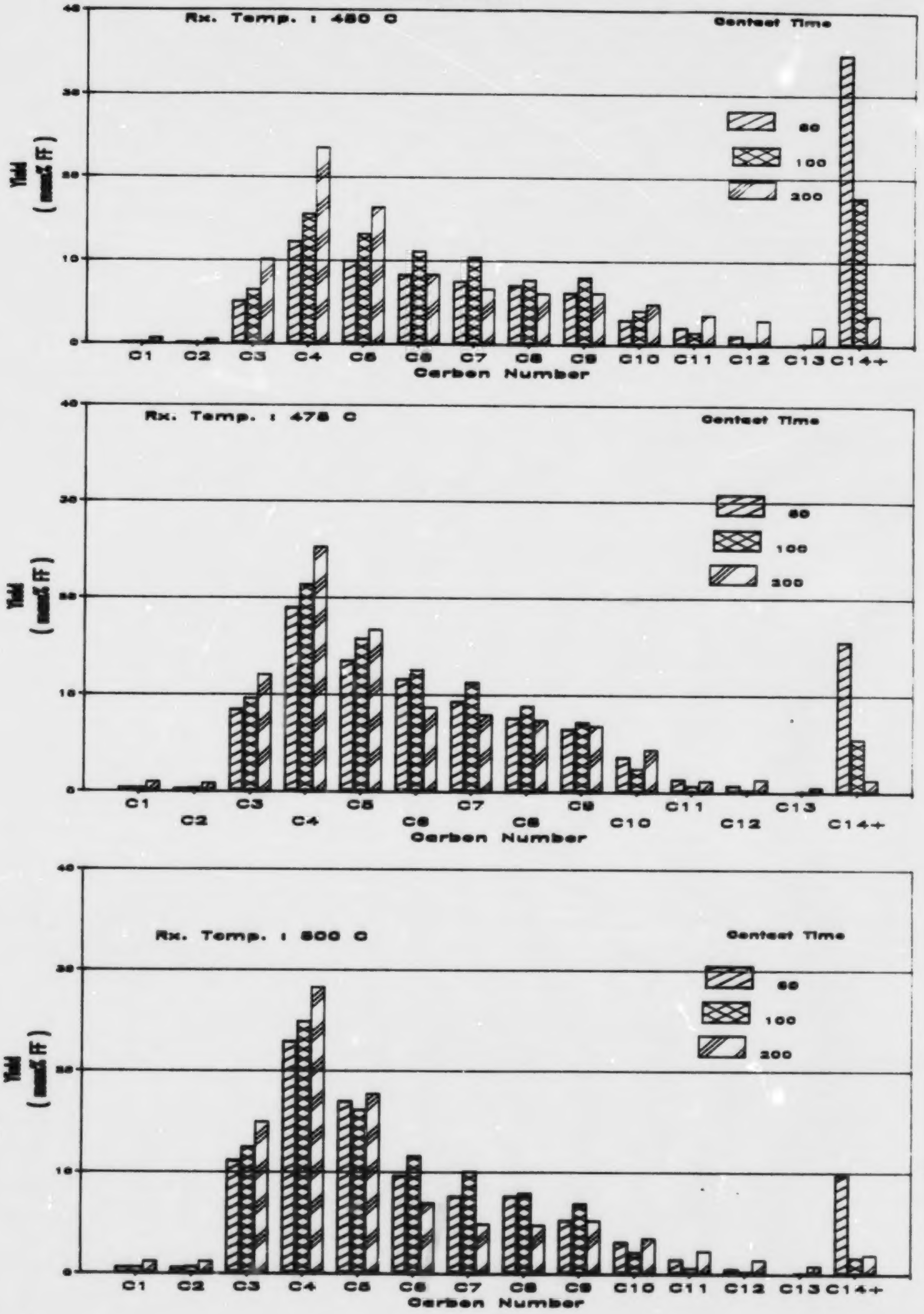


Figure 3.2.17

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION

Hexacosane

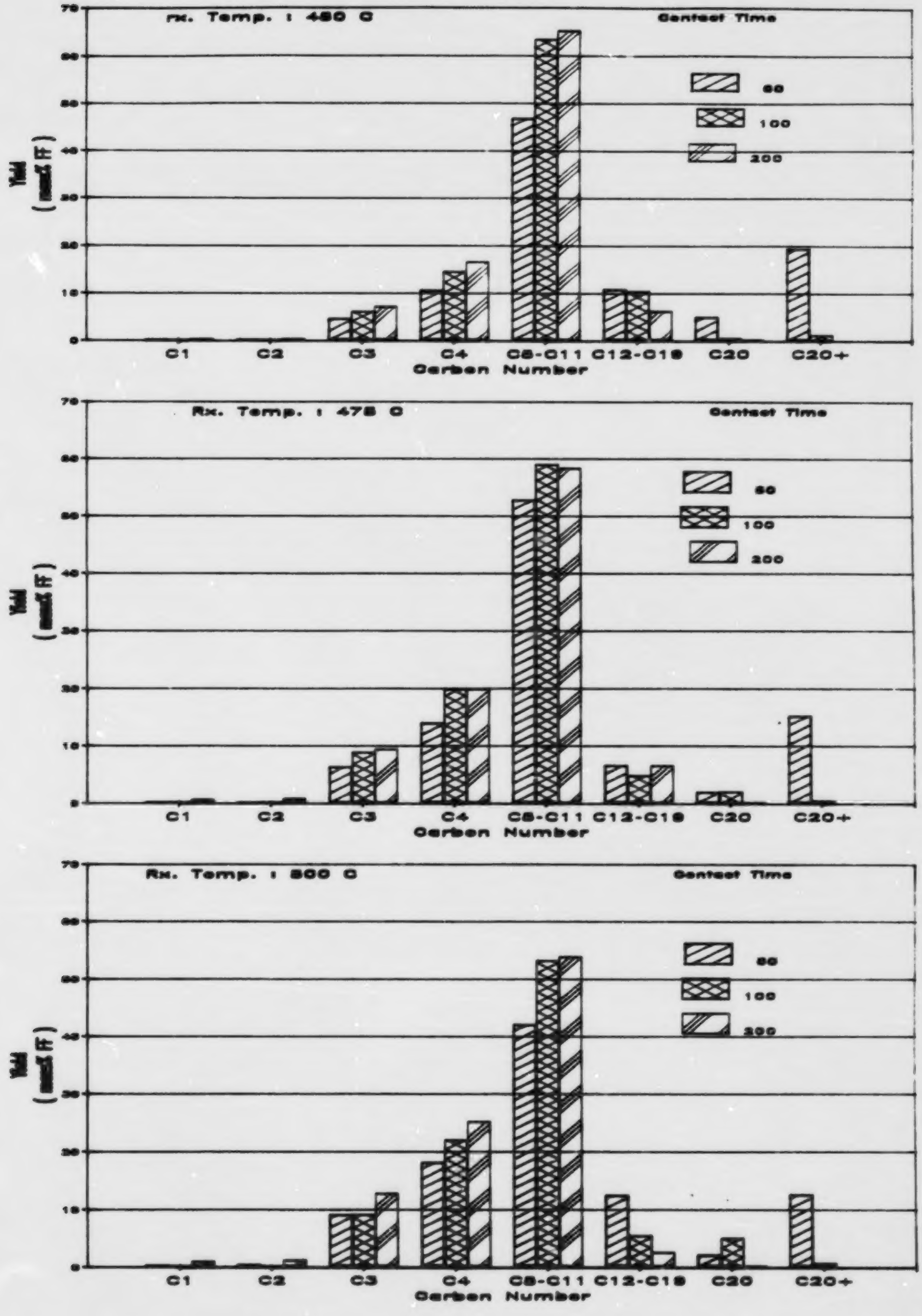


Figure 3.2.18

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION

Dotriacontane

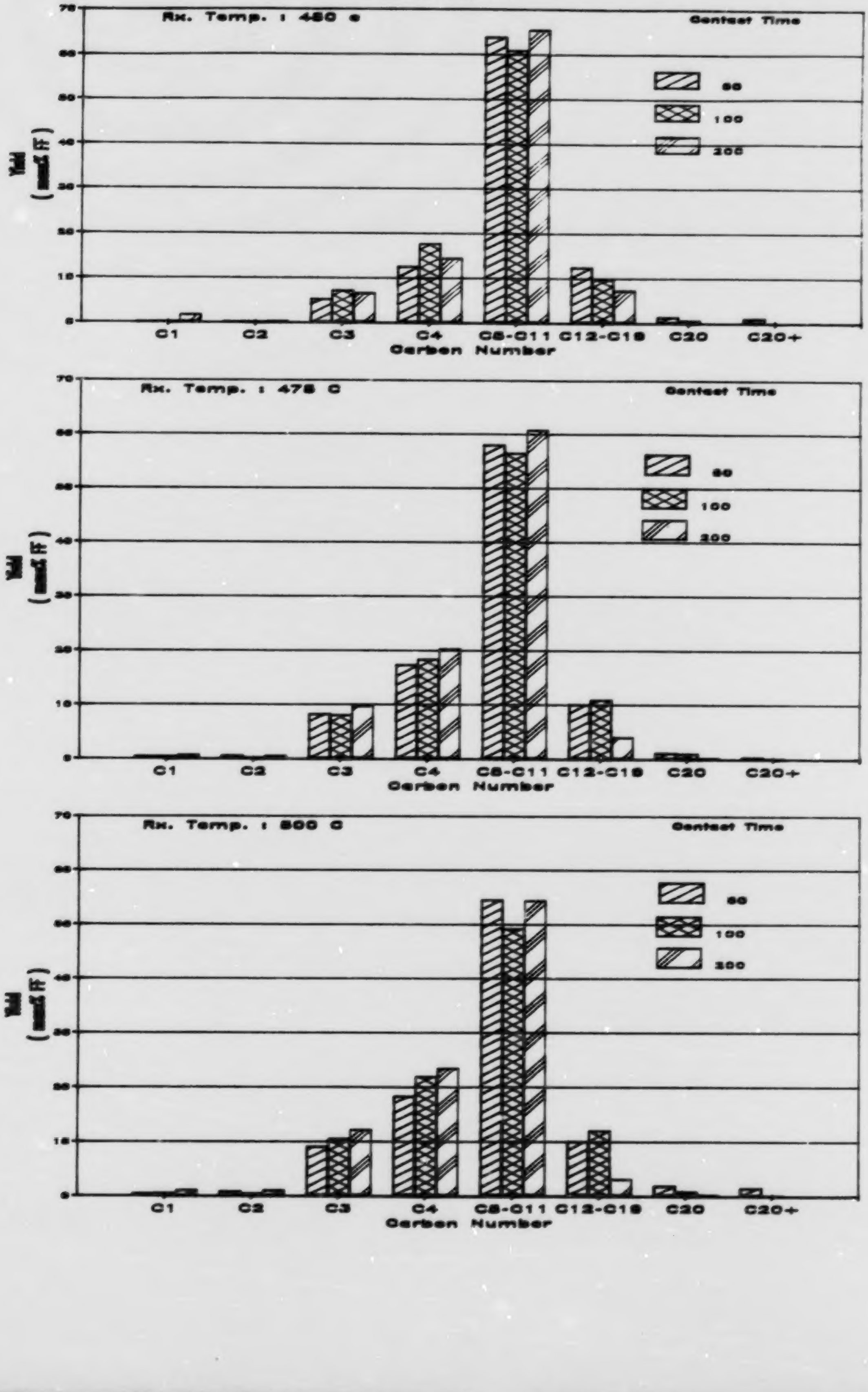


Figure 3.2.19
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane Rx. Temp : 450 C

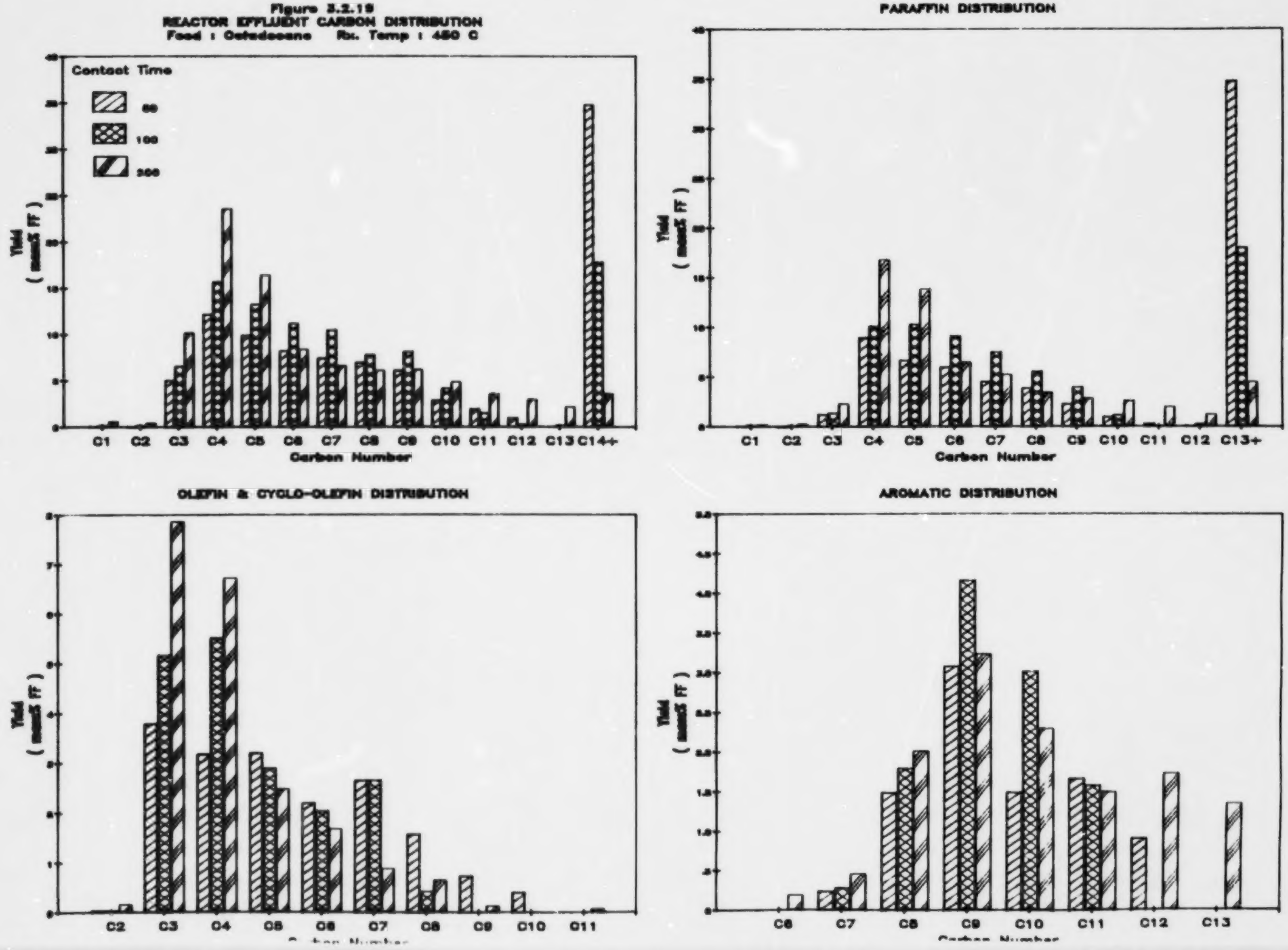
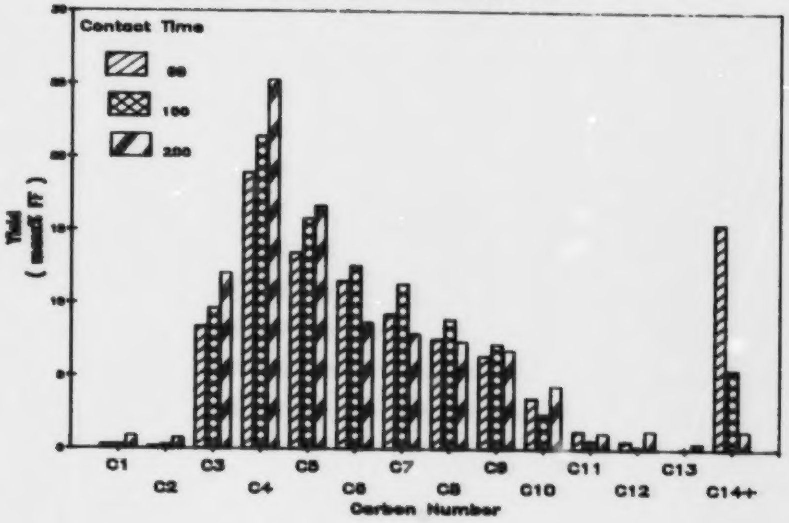
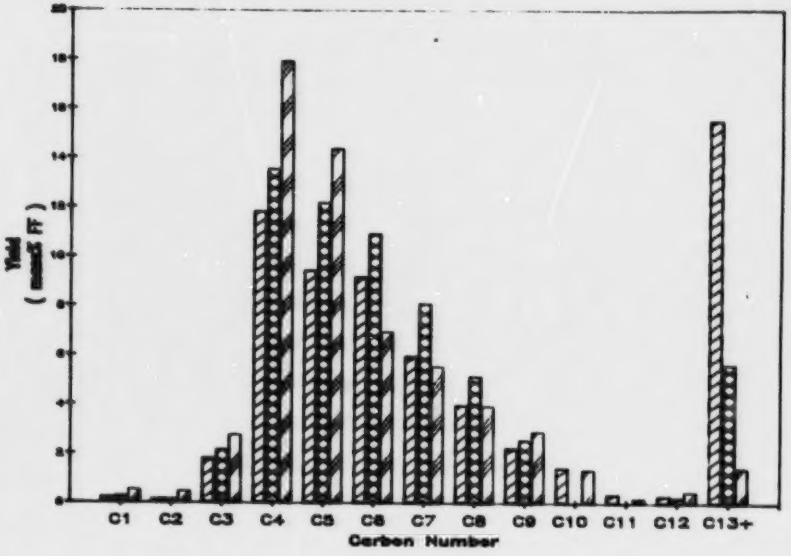


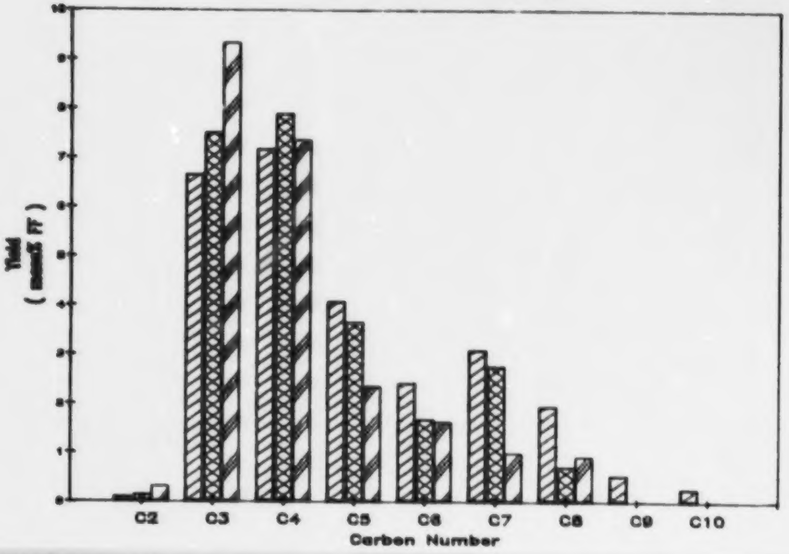
Figure 3.2.20
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane   Rx. Temp : 475 C



PARAFFIN DISTRIBUTION



OLEFIN & CYCLO-OLEFIN DISTRIBUTION



AROMATIC DISTRIBUTION

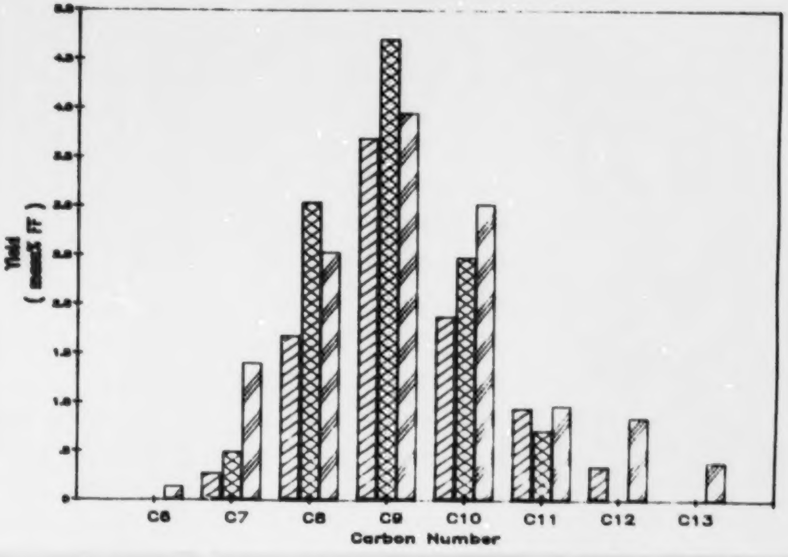
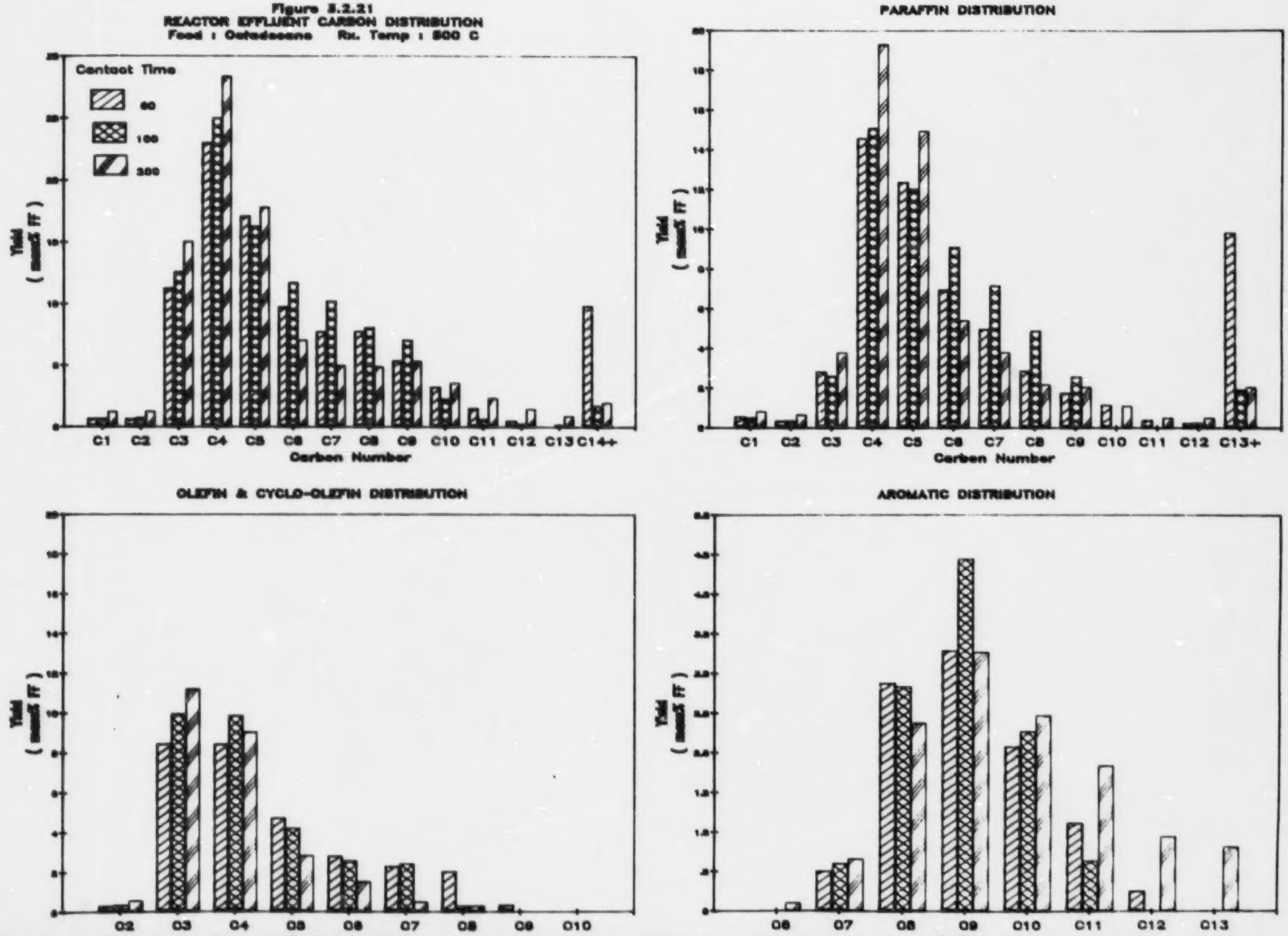


Figure 3.2.21
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane Rx. Temp : 500 C


PARAFFIN DISTRIBUTION

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

AROMATIC DISTRIBUTION

Figure 3.2.22
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexadecane Rx. Temp : 480 C

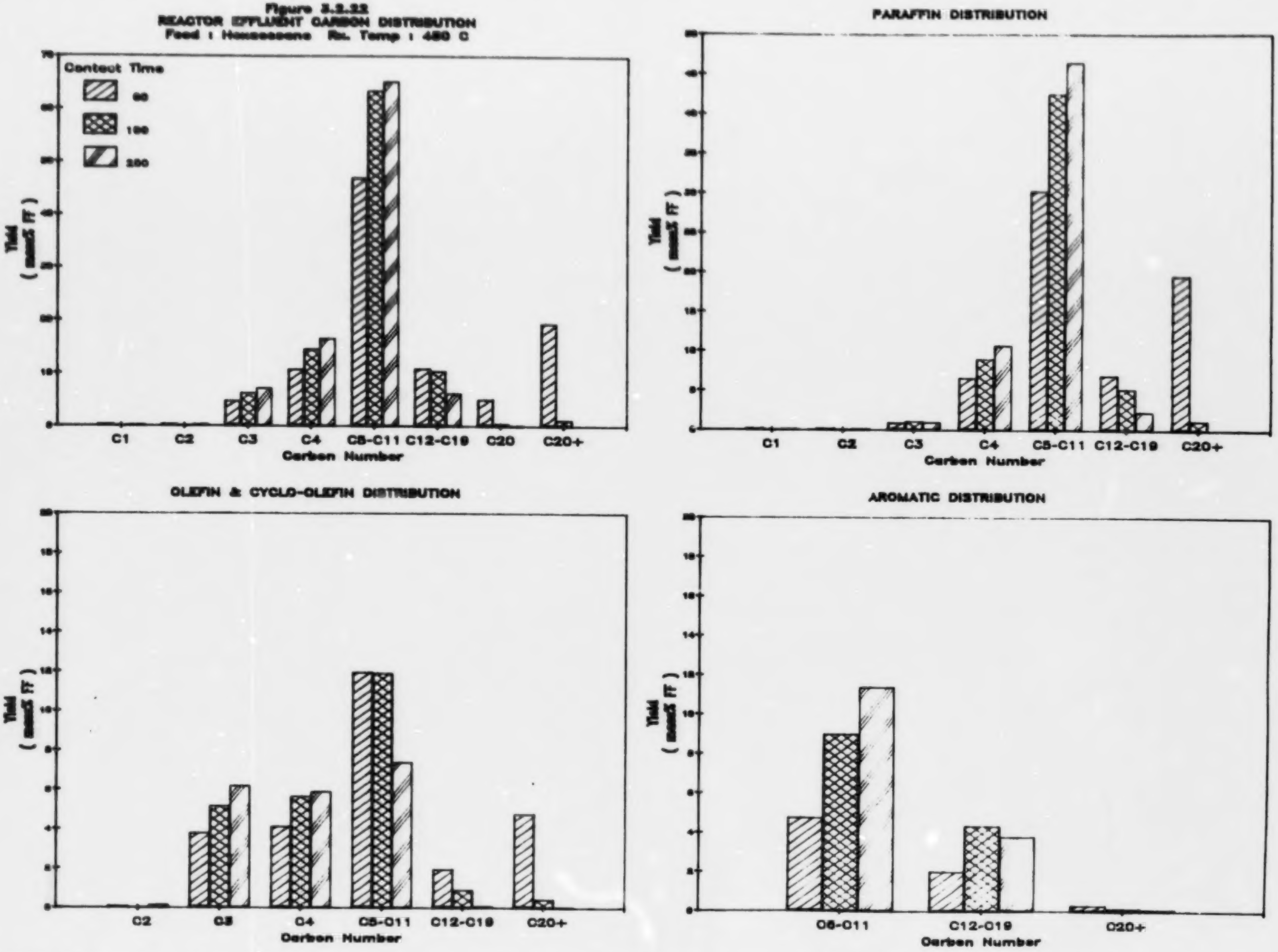


Figure 3.2.23
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexadecene Rx. Temp : 475 C

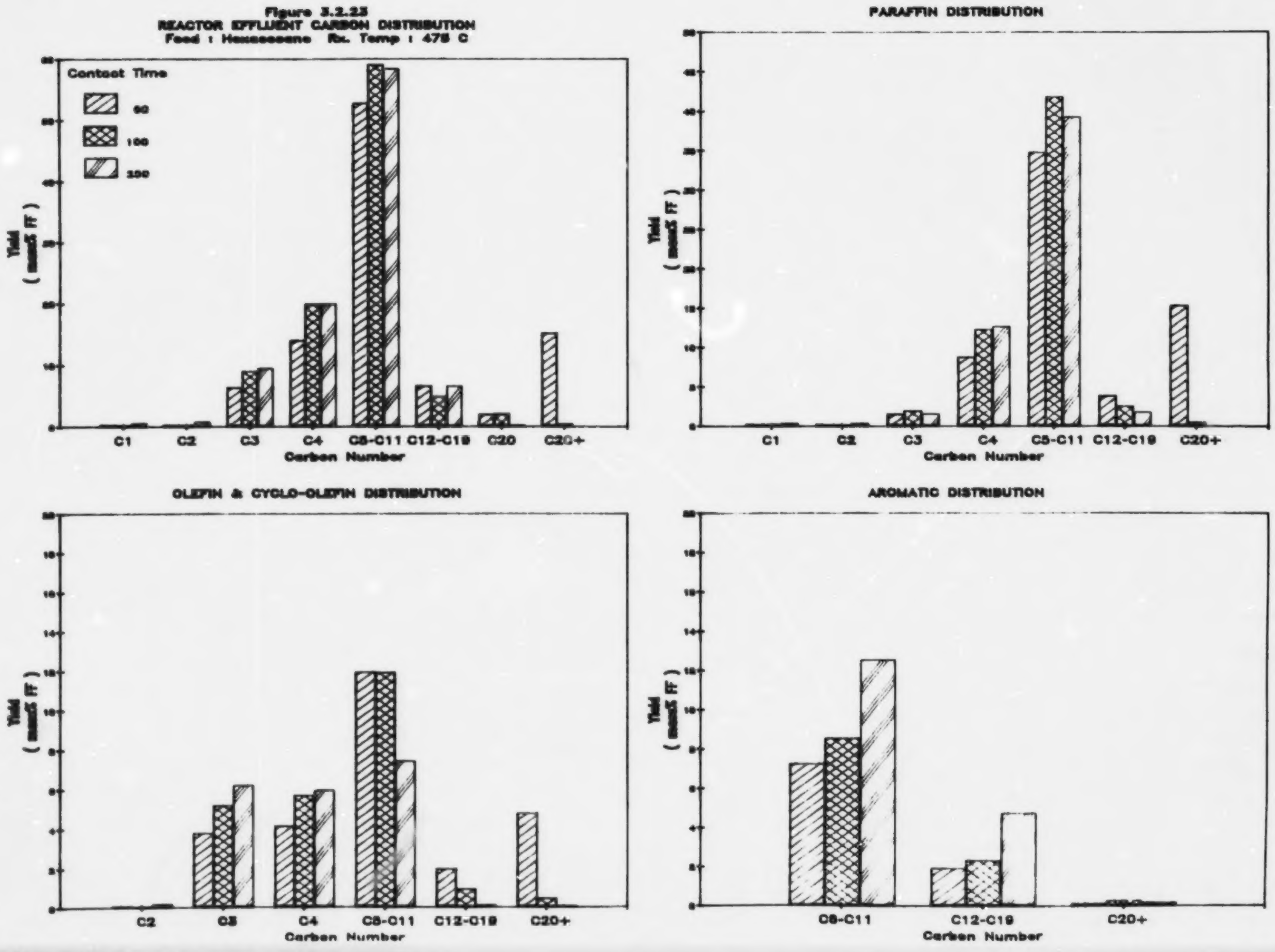


Figure 5.2.24
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexadecane Rx. Temp : 500 C

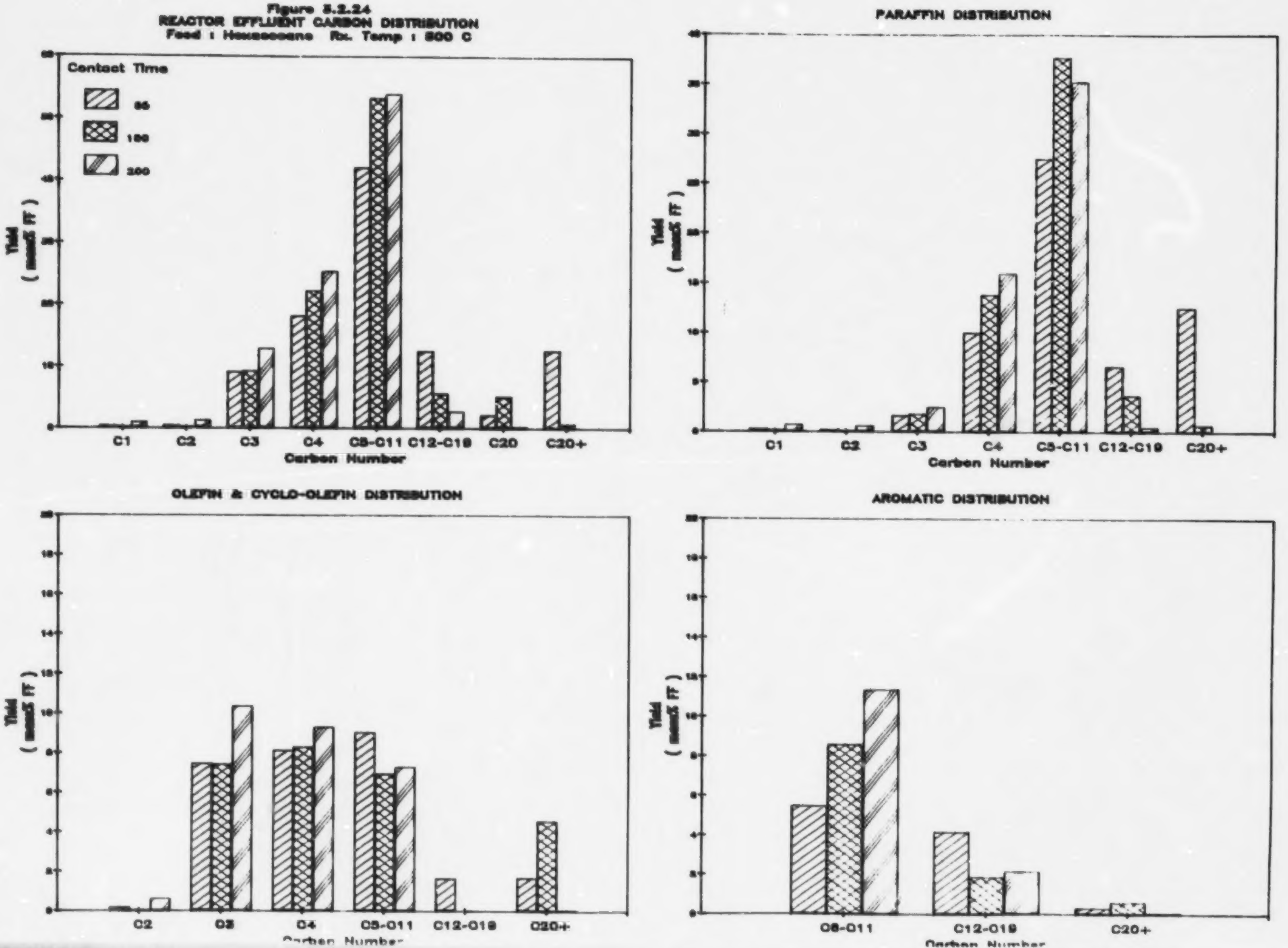


Figure 3.2.25
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Dotriacontane Rx. Temp 450 C

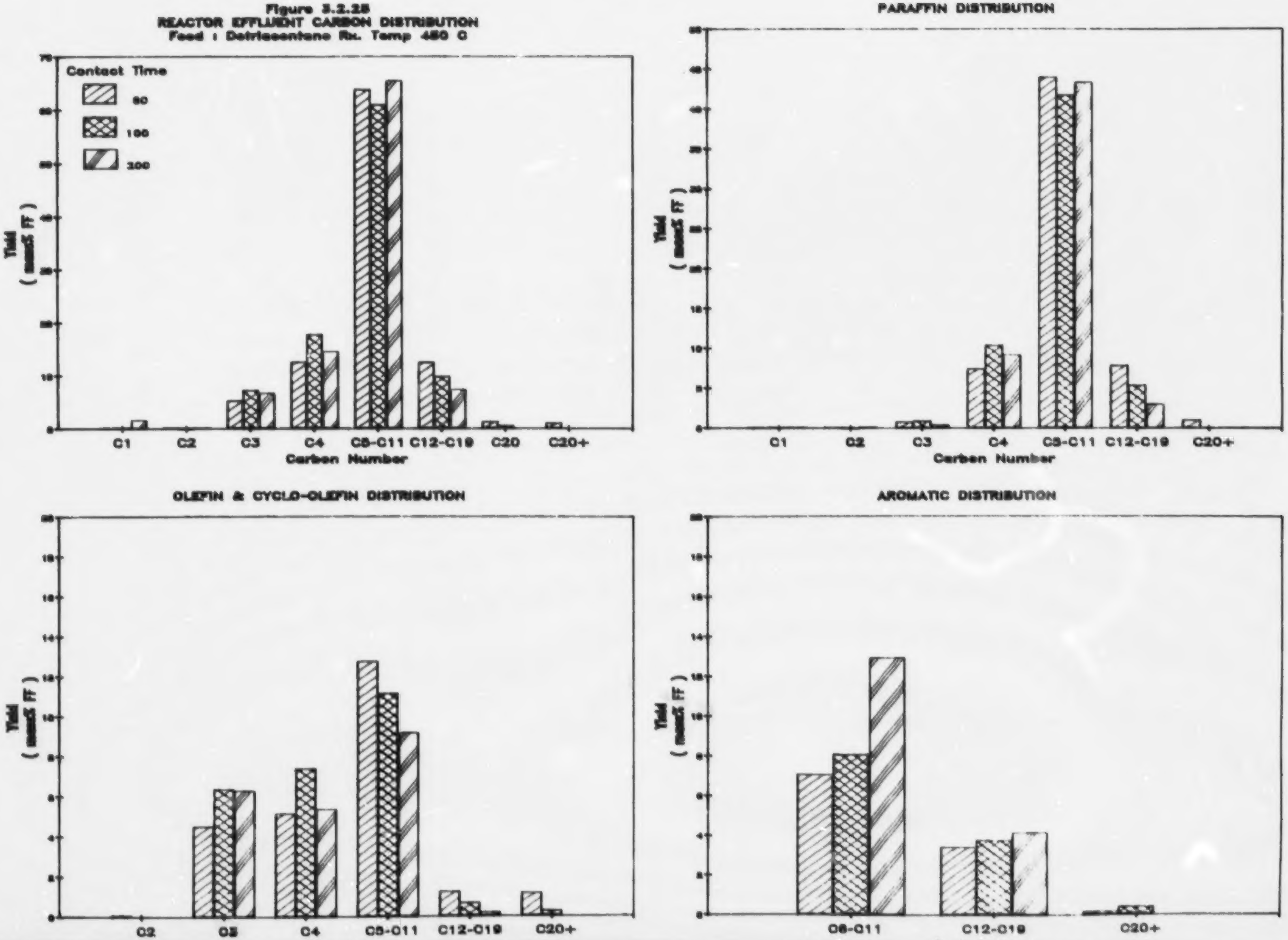
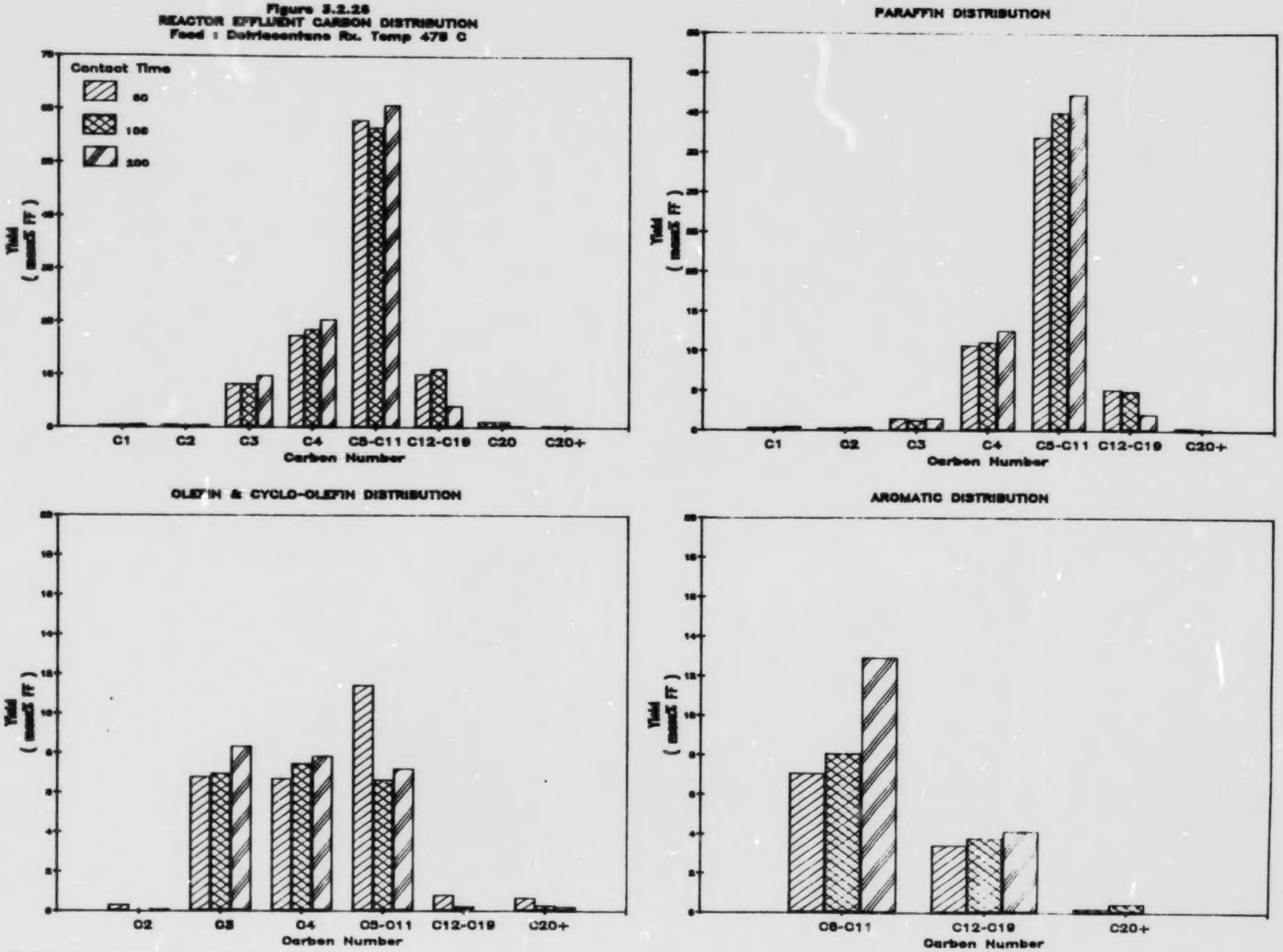


Figure 3.2.28
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Dotriacontane Rx. Temp 475 C



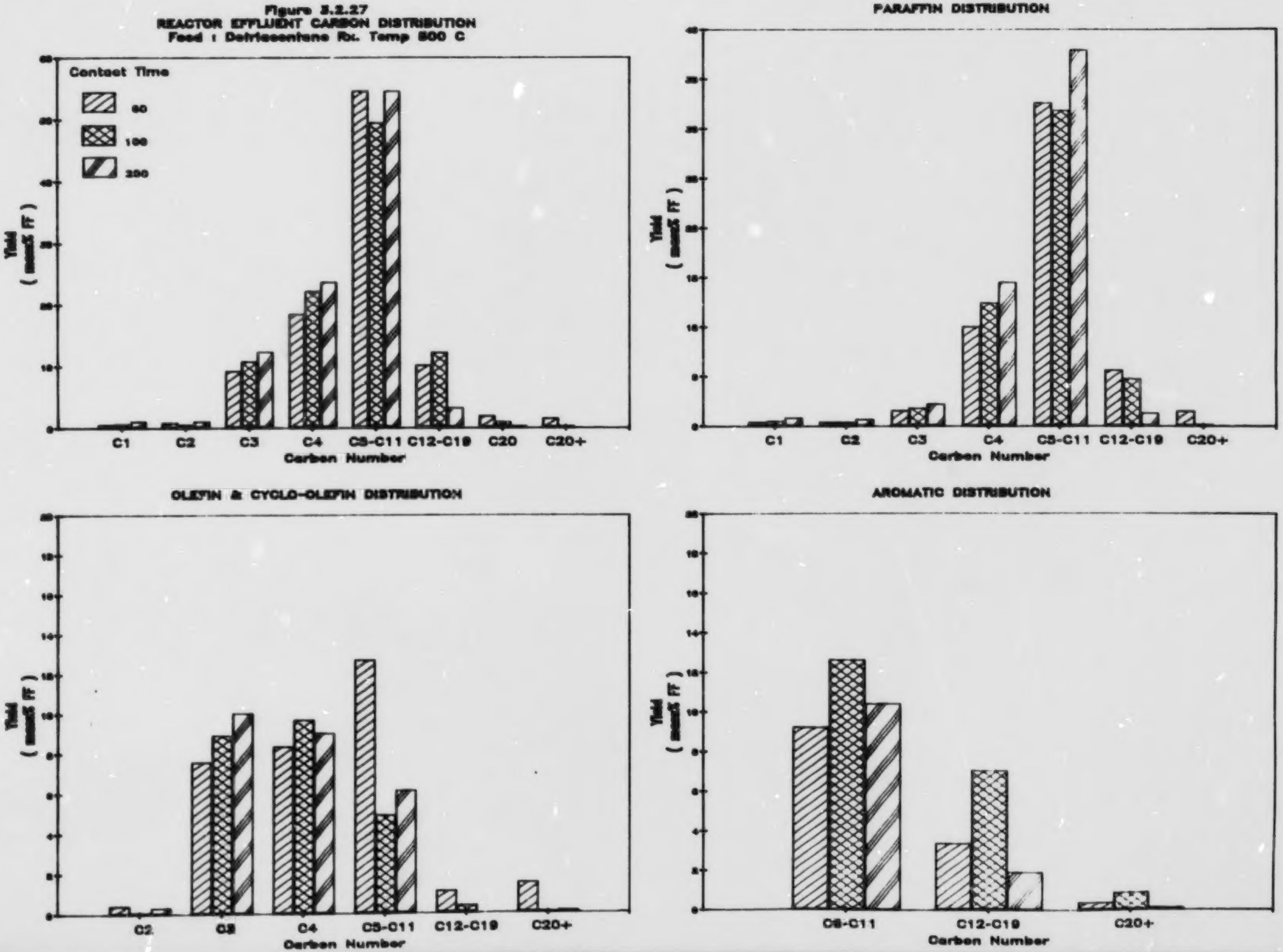


Figure 3.2.27
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Dotriacontane Rx. Temp 500 C

Figure 3.3.1

Cracking Patterns for 2,6,10,14 - Tetramethylpentadecane

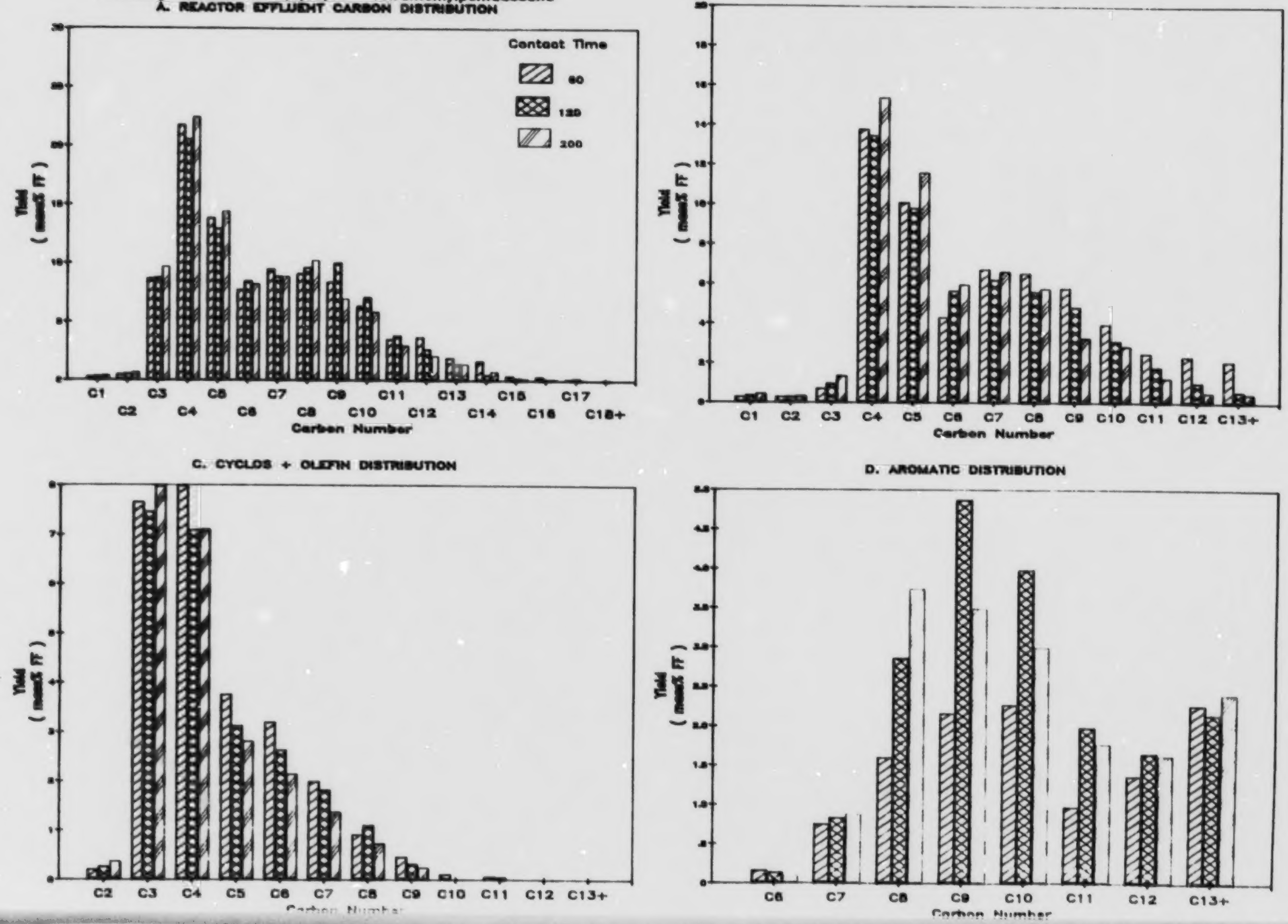


Figure 3.3.2
Cracking Patterns for 1 - Octadecene

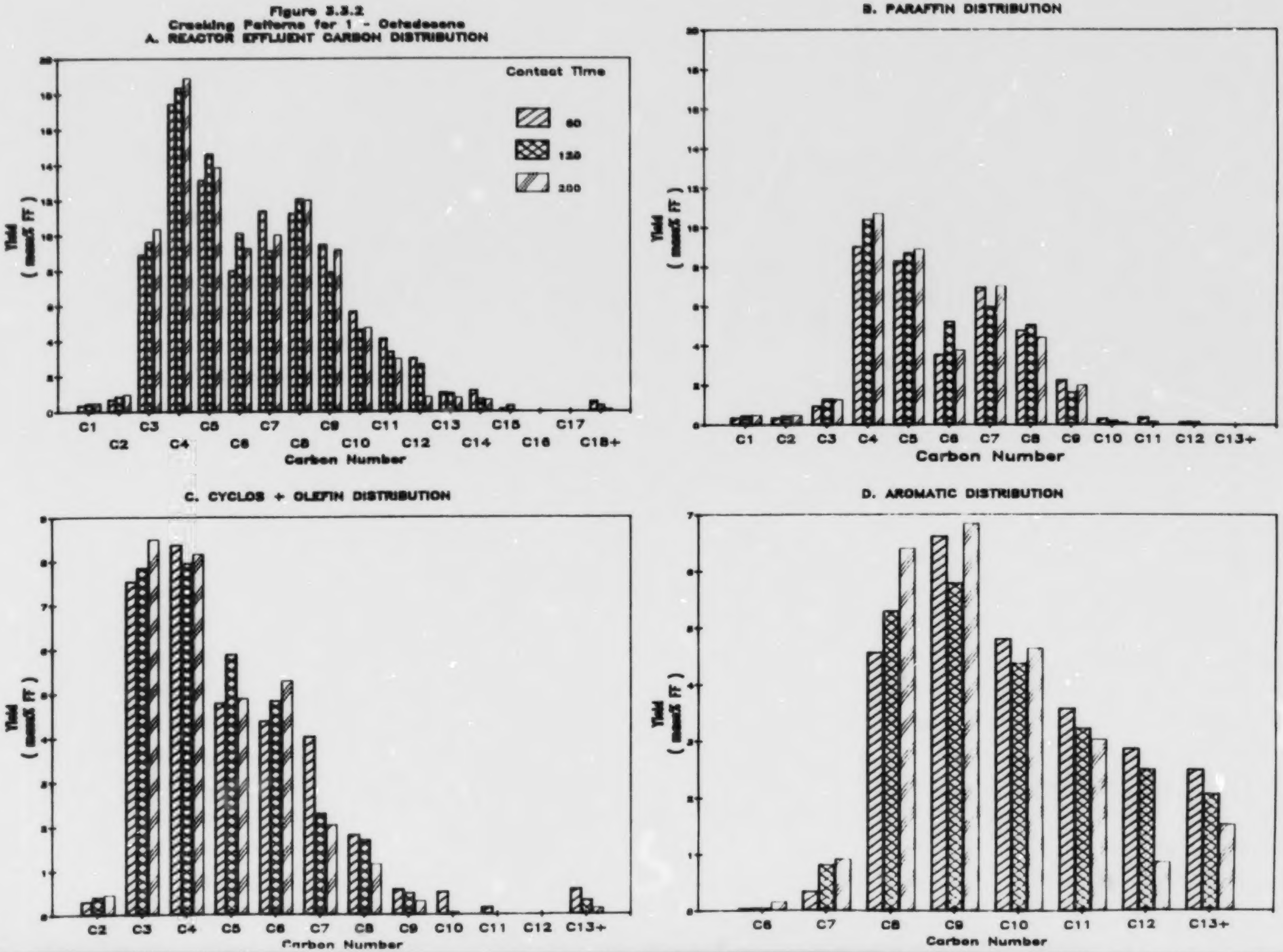


Figure 3.3.3
Cracking Patterns for 1,3,5 - Triisopropylcyclohexane

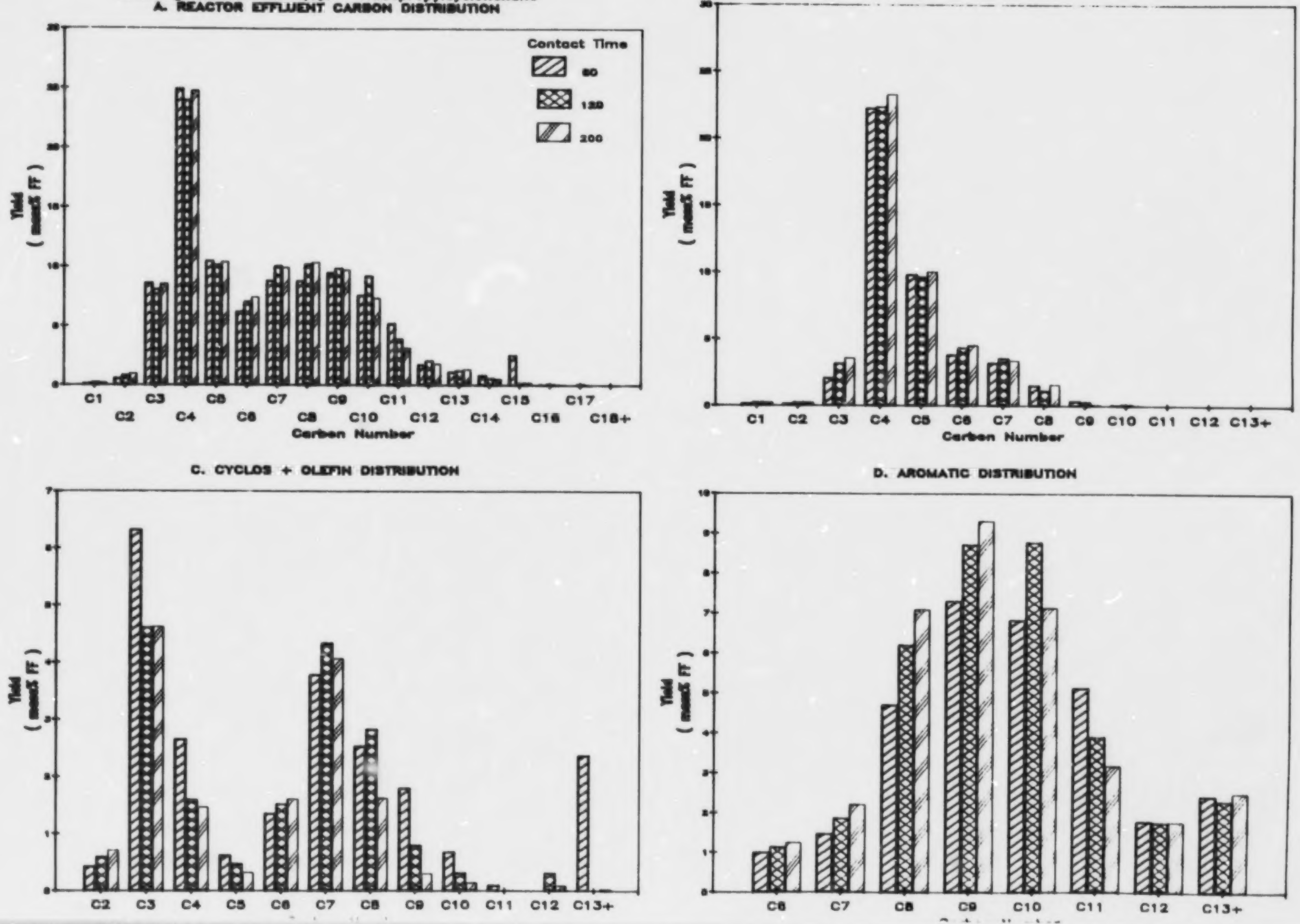
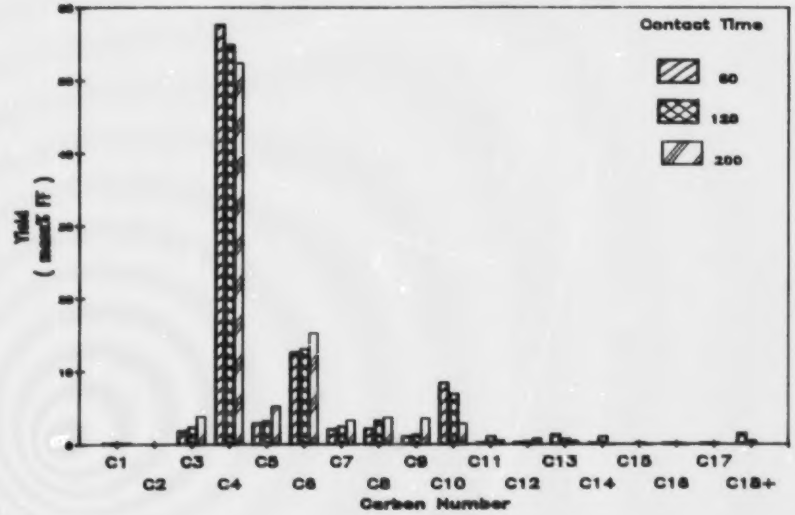
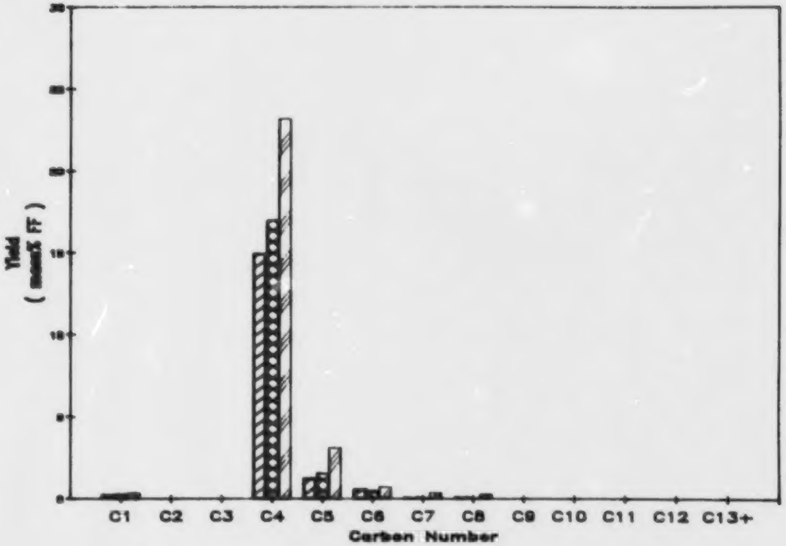


Figure 3.3.4
Cracking Patterns for 1,3,5 - Tri-t-Butylbenzene

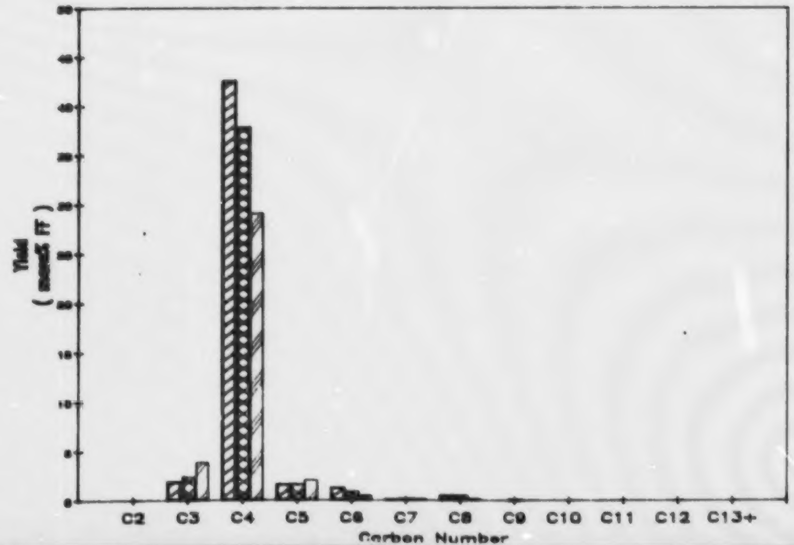
A. REACTOR EFFLUENT CARBON DISTRIBUTION



B. PARAFFIN DISTRIBUTION



C. CYCLOS + OLEFIN DISTRIBUTION



D. AROMATIC DISTRIBUTION

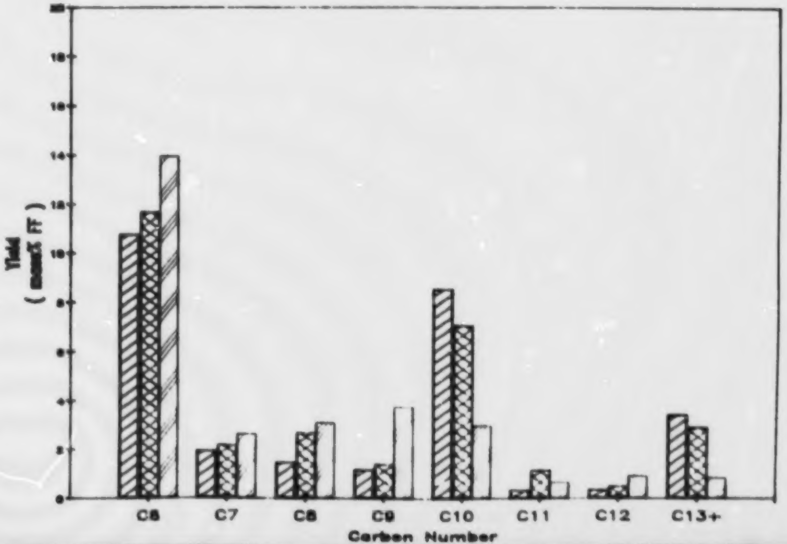
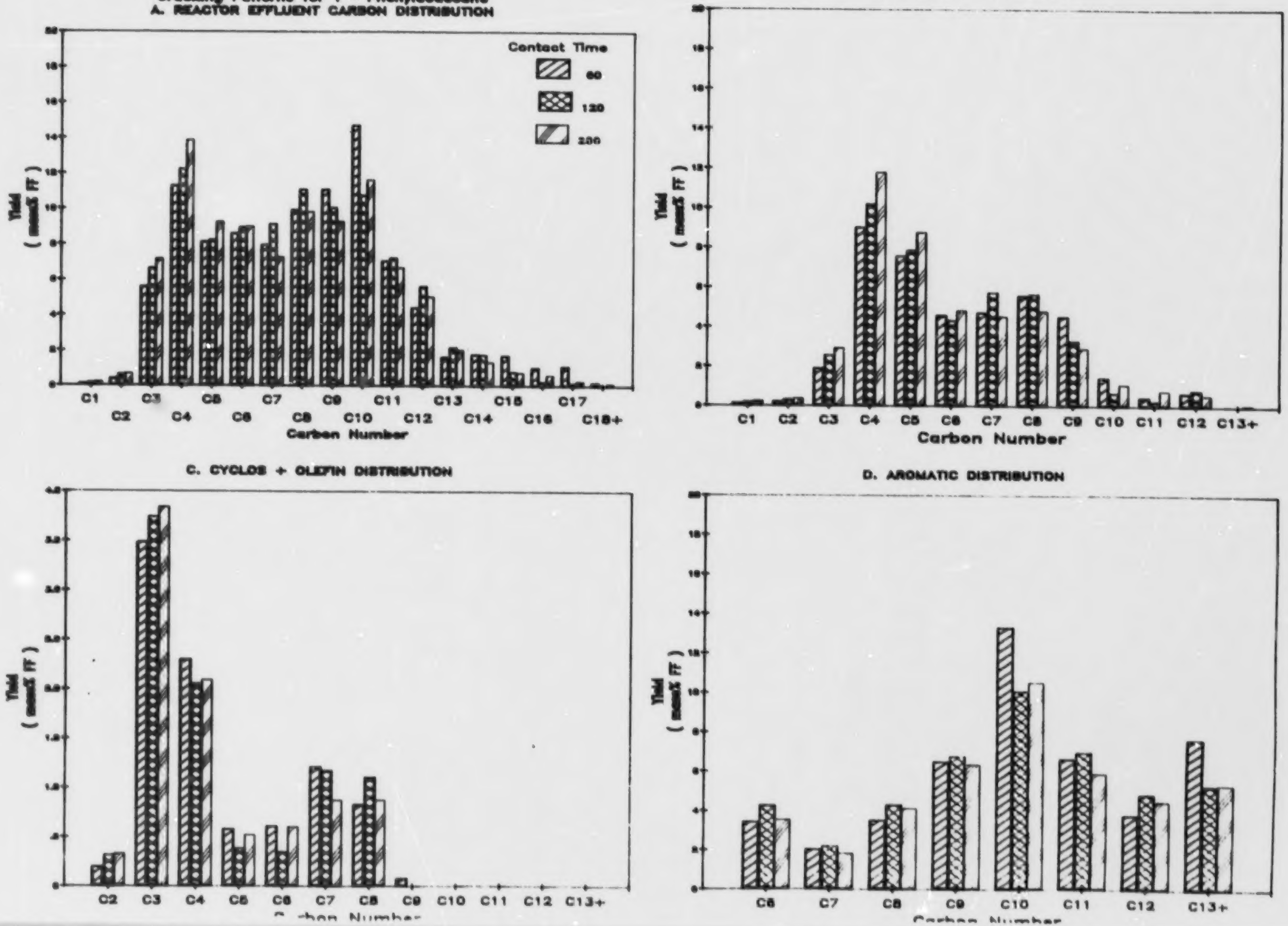


Figure 3.3.8
Cracking Patterns for 1 - Phenyldodecane



A. REACTOR EFFLUENT CARBON DISTRIBUTION

B. PARAFFIN DISTRIBUTION

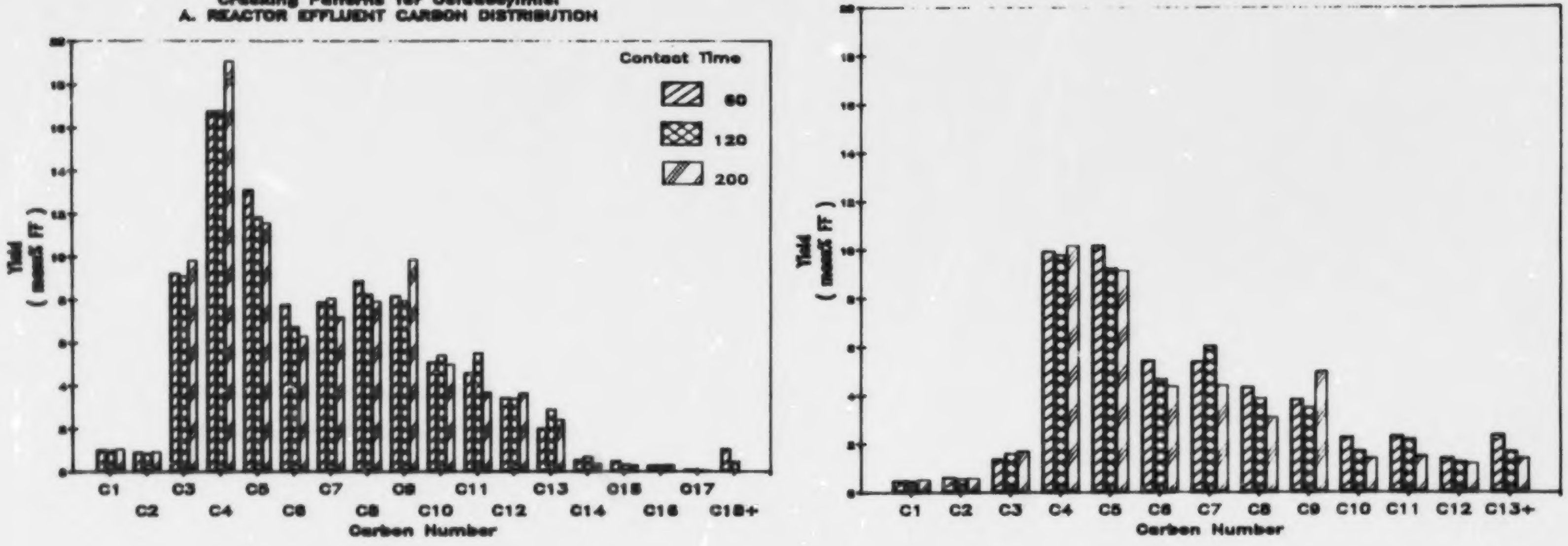
C. CYCLOS + OLEFIN DISTRIBUTION

D. AROMATIC DISTRIBUTION

Figure 3.4.1

Cracking Patterns for Octadecylthiol

A. REACTOR EFFLUENT CARBON DISTRIBUTION



B. PARAFFIN DISTRIBUTION

C. CYCLOS + OLEFIN DISTRIBUTION

D. AROMATIC DISTRIBUTION

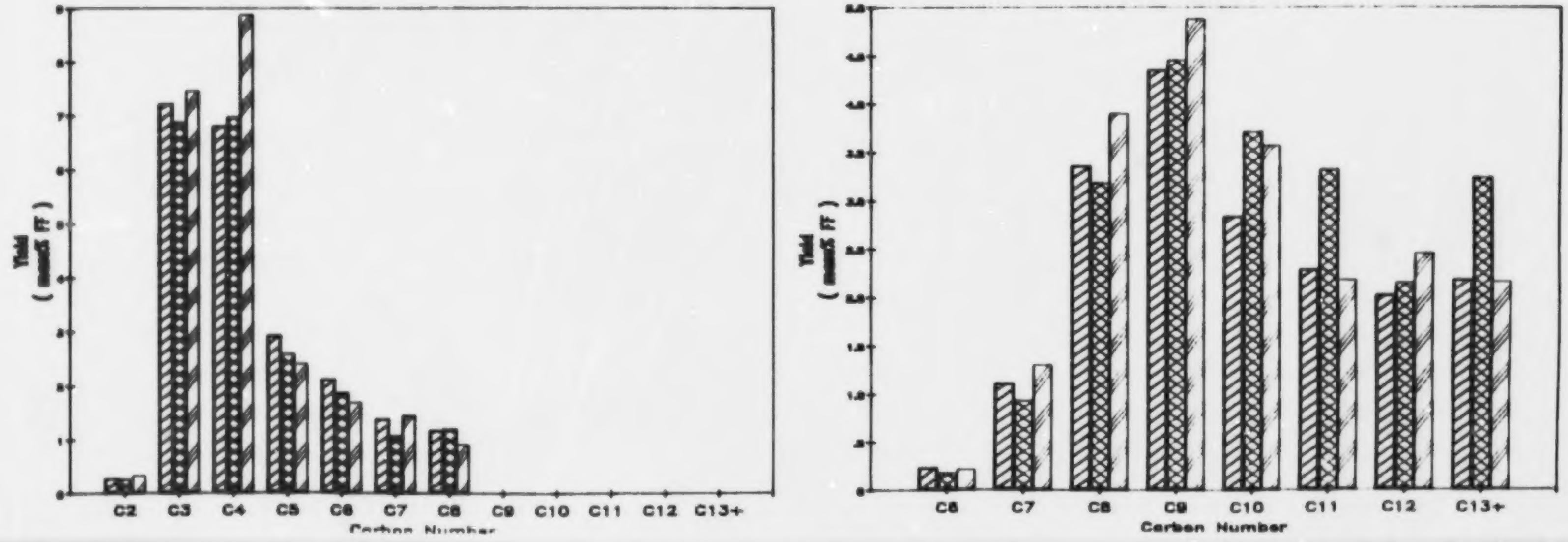
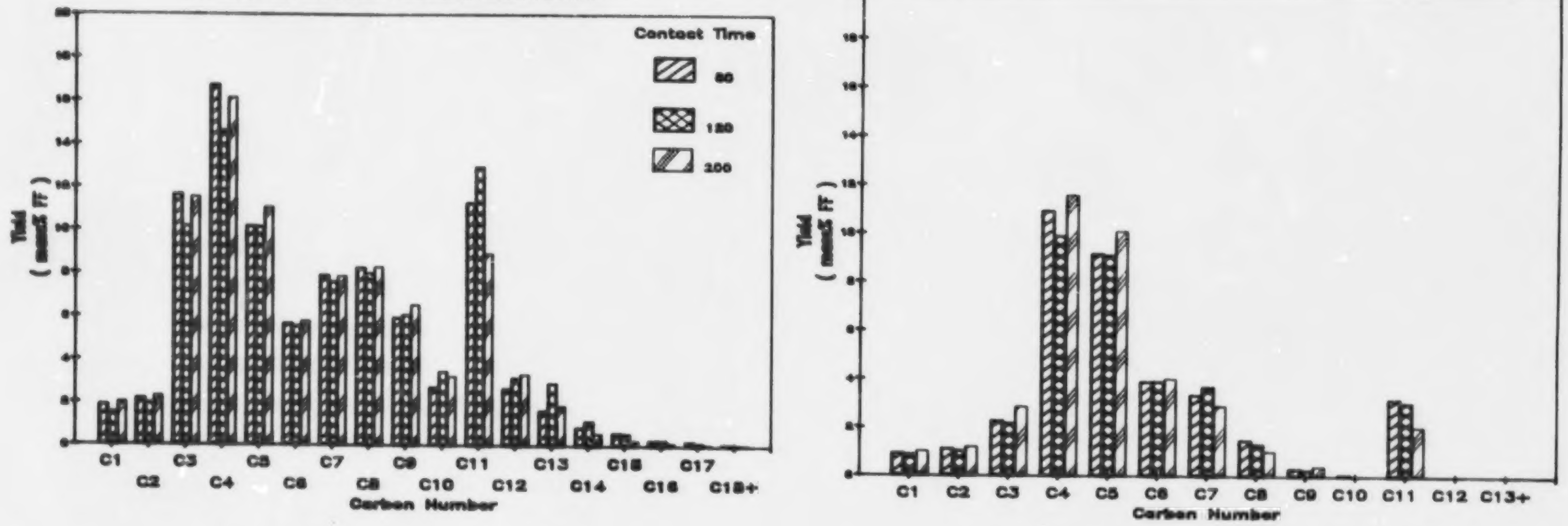


Figure 3.4.2
Cracking Patterns for n-Undecylsulfide

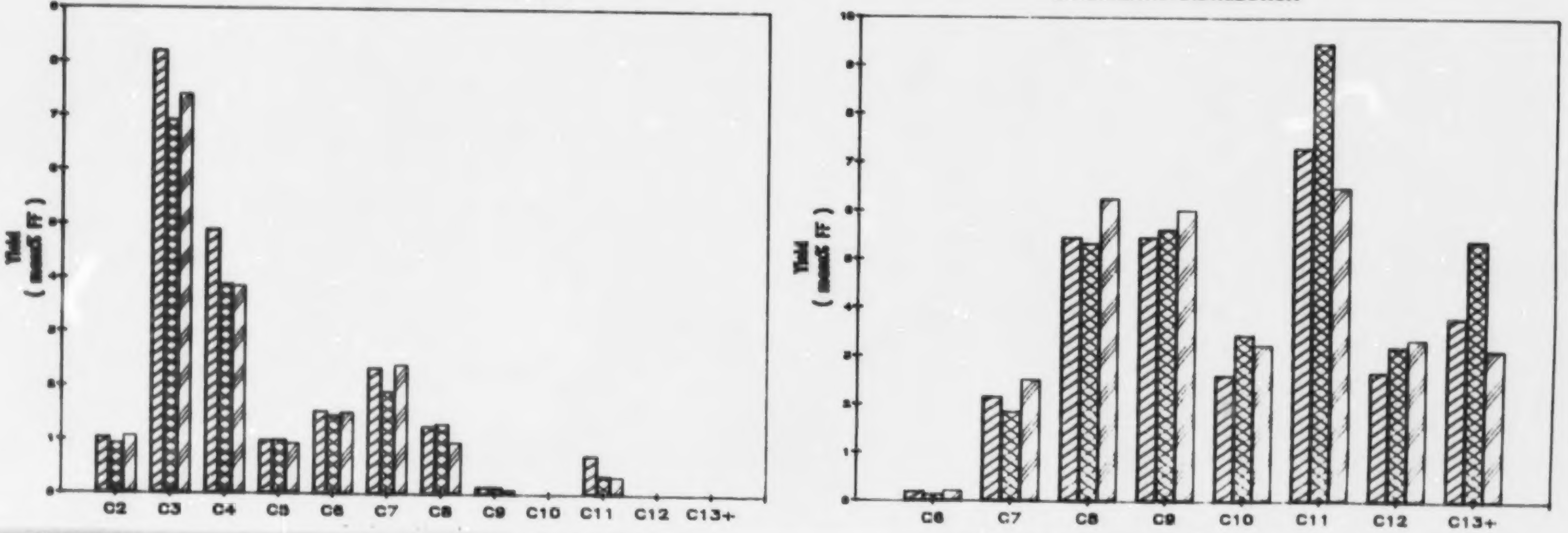
A. REACTOR EFFLUENT CARBON DISTRIBUTION

B. PARAFFIN DISTRIBUTION



C. CYCLOS + OLEFIN DISTRIBUTION

D. AROMATIC DISTRIBUTION



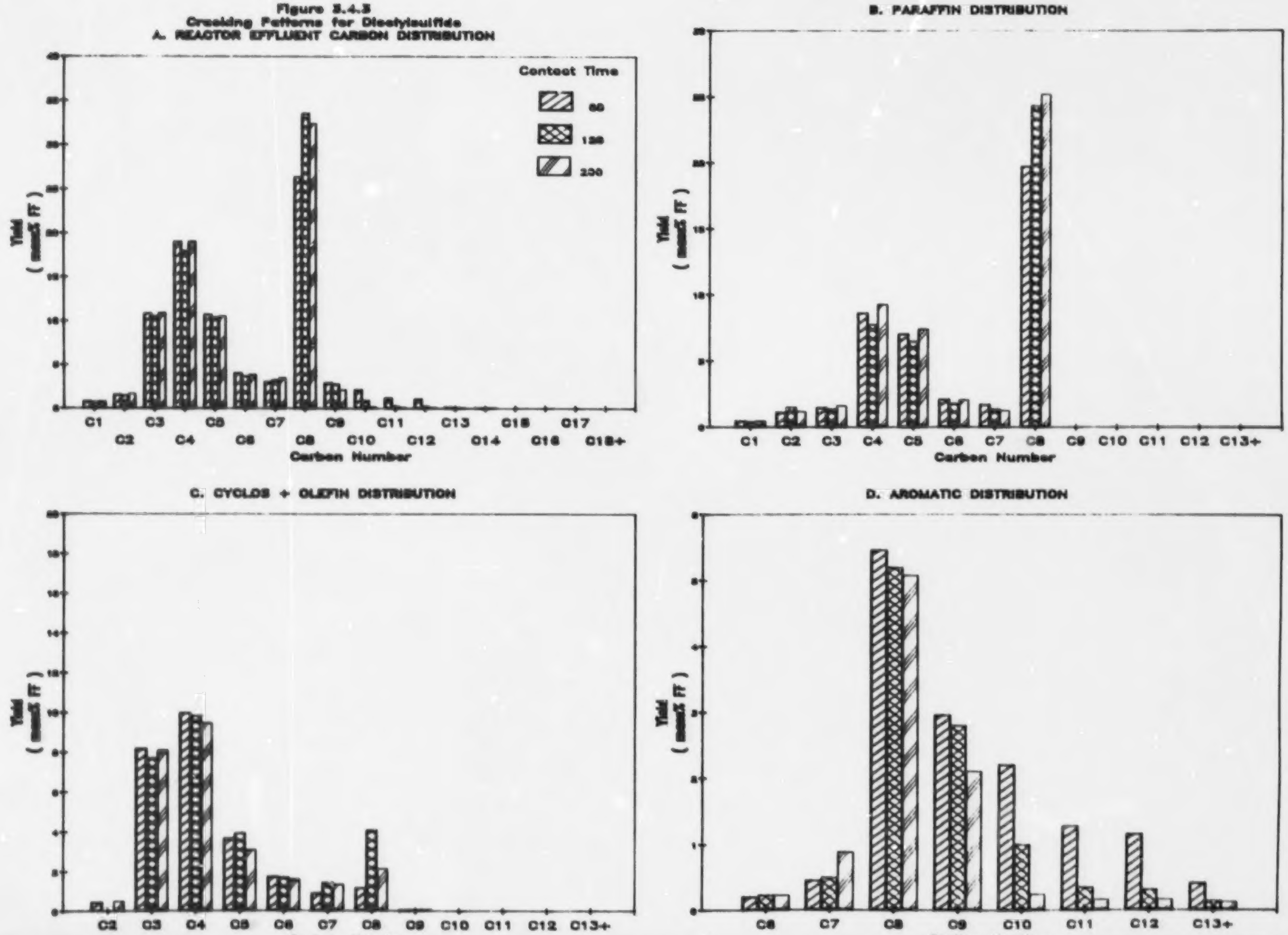


Figure 3.4.3
Cracking Patterns for Dioctylsulfide
A. REACTOR EFFLUENT CARBON DISTRIBUTION

B. PARAFFIN DISTRIBUTION

C. CYCLOS + OLEFIN DISTRIBUTION

D. AROMATIC DISTRIBUTION

Figure 3.5.1 Nitrogen Poisoning - Conversion

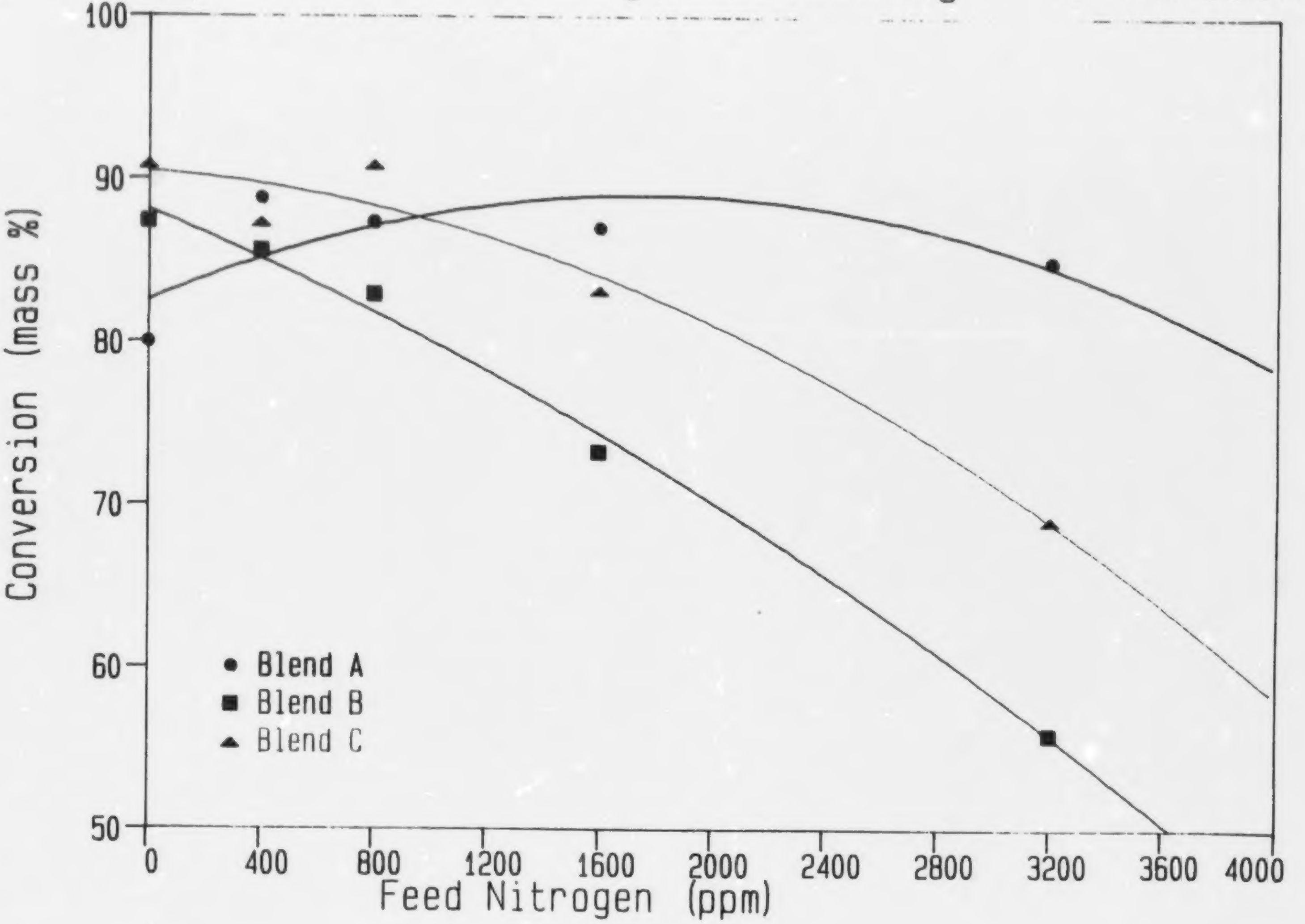


Figure 3.5.2 Nitrogen Poisoning - C5+Gasoline

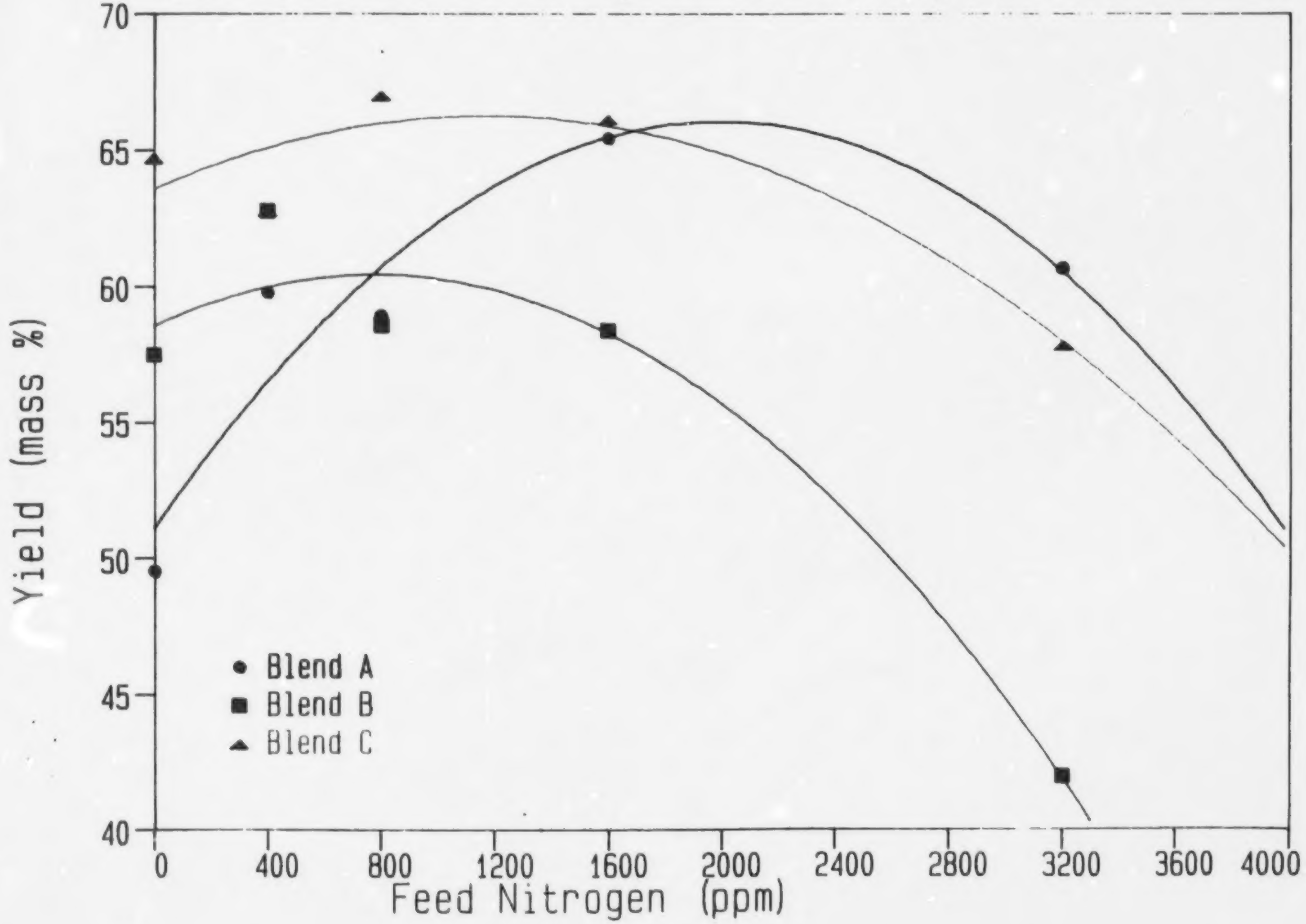


Figure 3.5.3 Nitrogen Poisoning - LCO + DO Yields

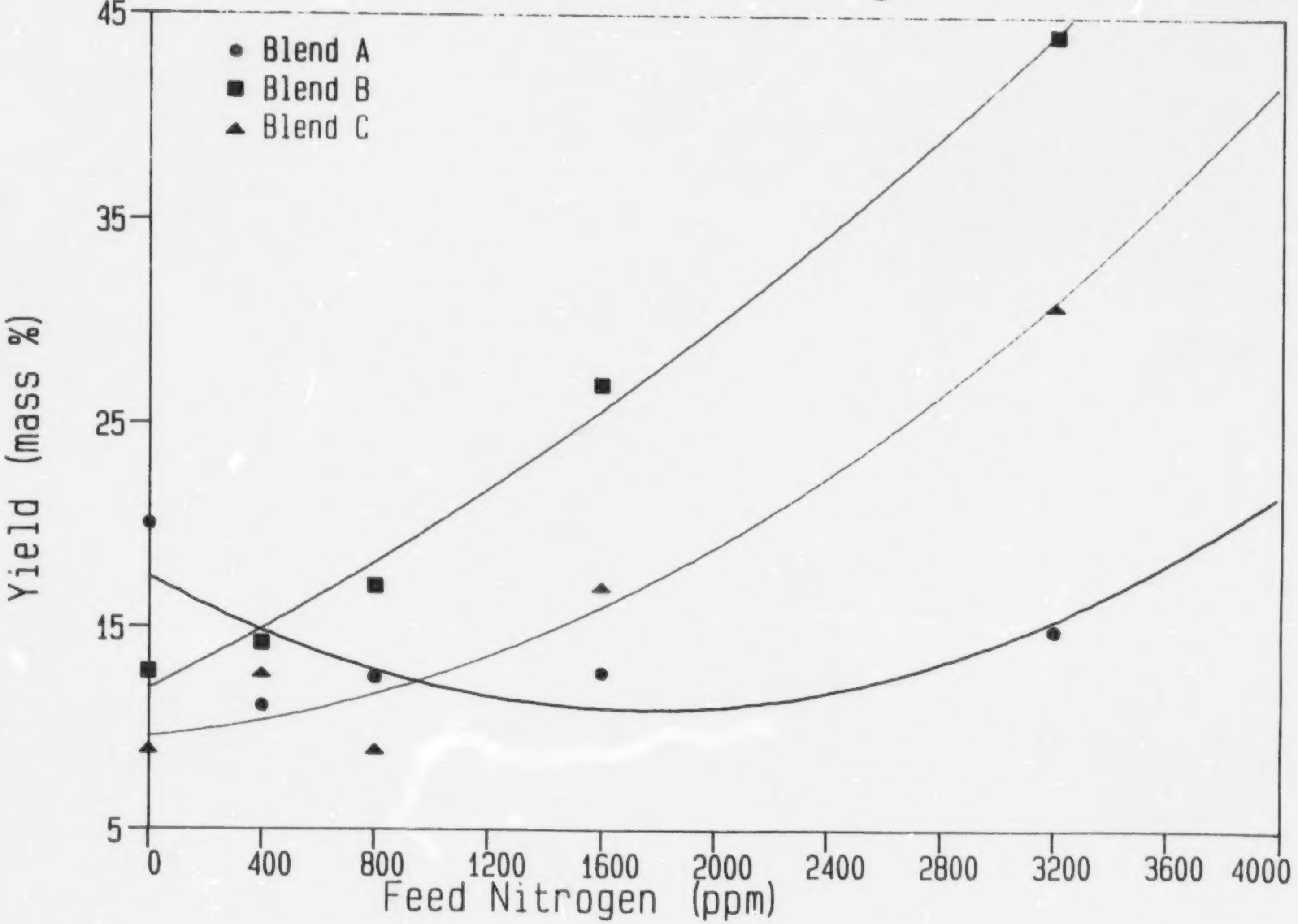


Figure 3.5.4 Nitrogen Poisoning - Coke Yields

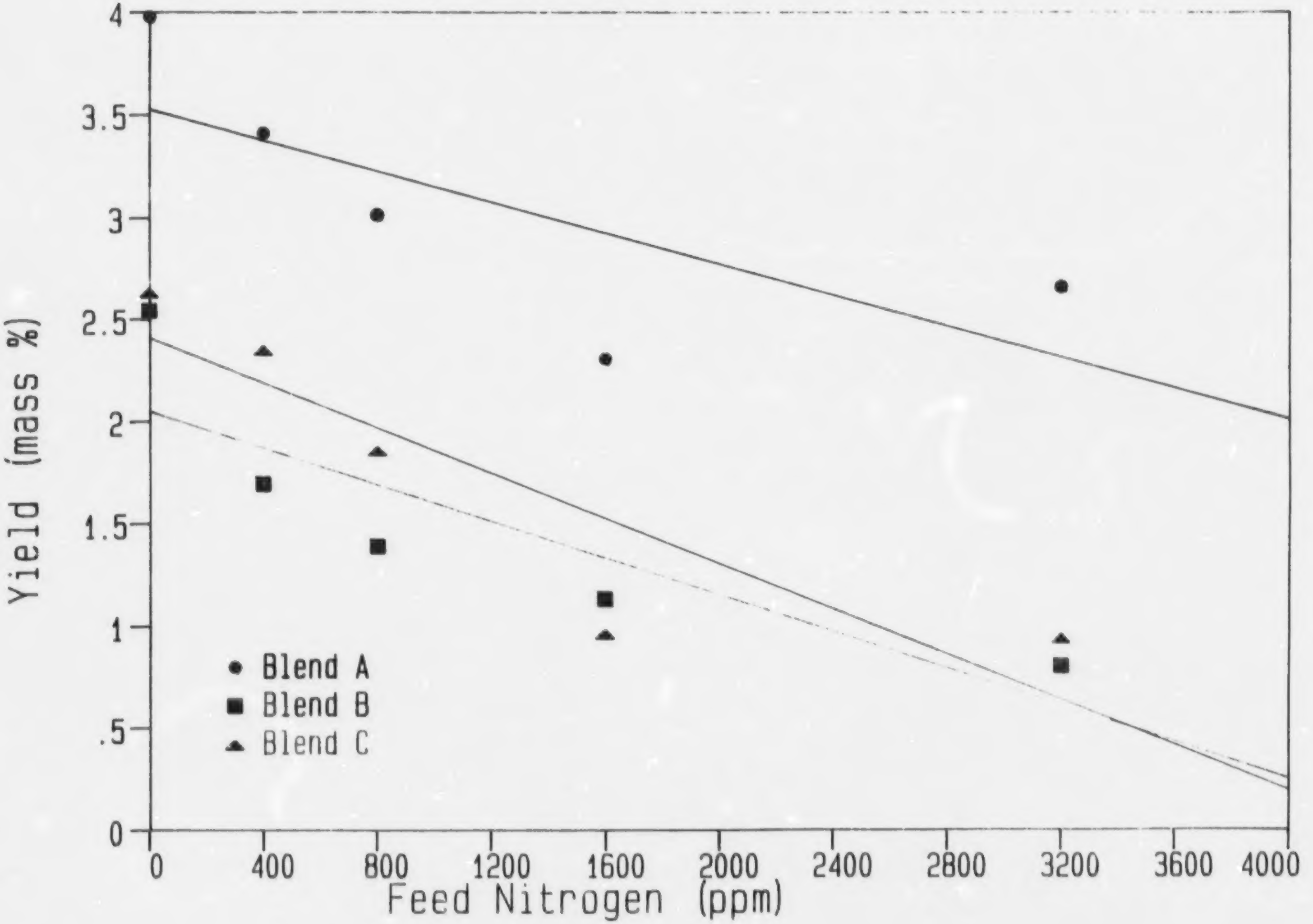


Figure 3.5.5 Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION
Blend A

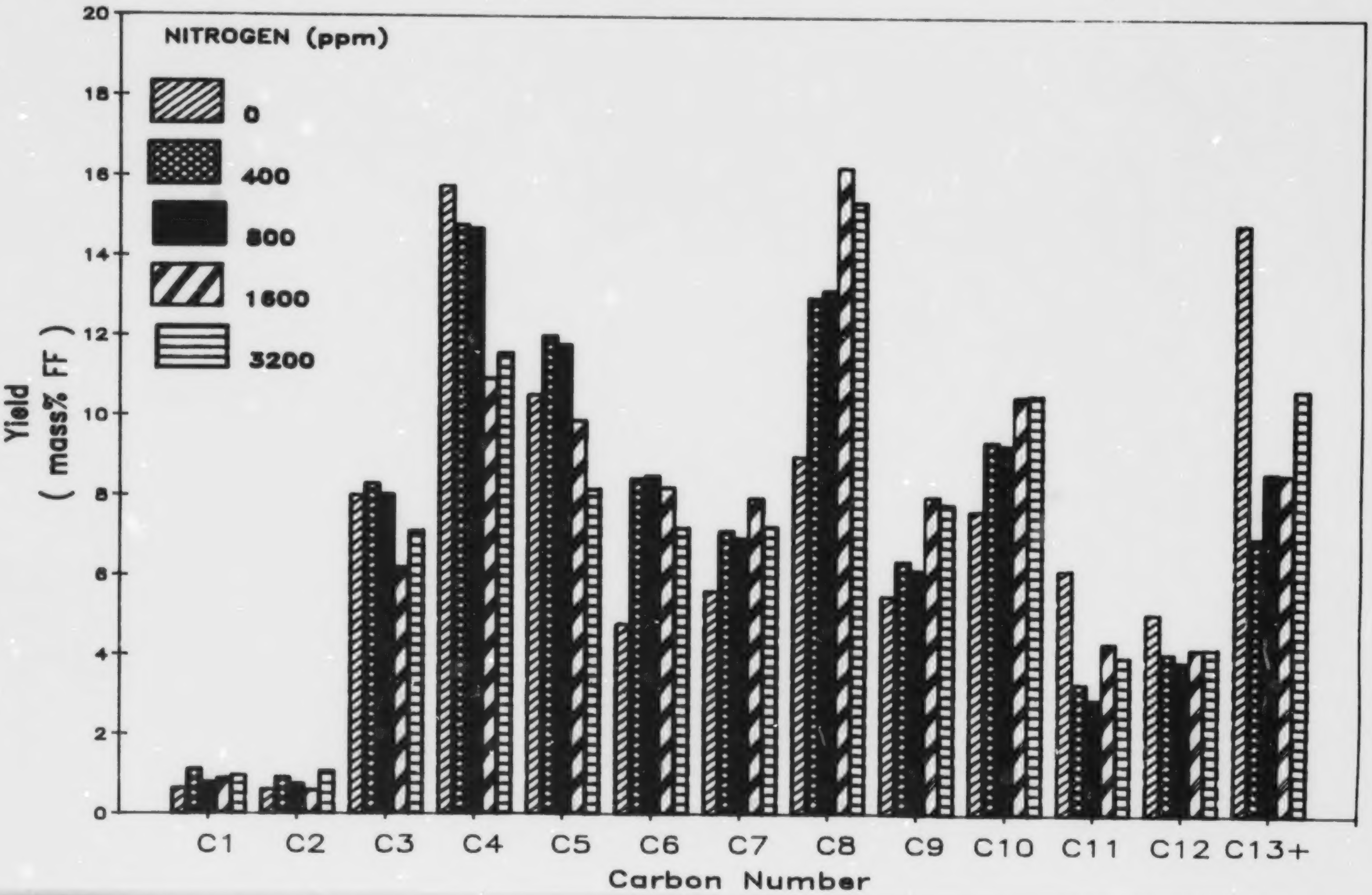


Figure 3.5.6 Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

Blend B

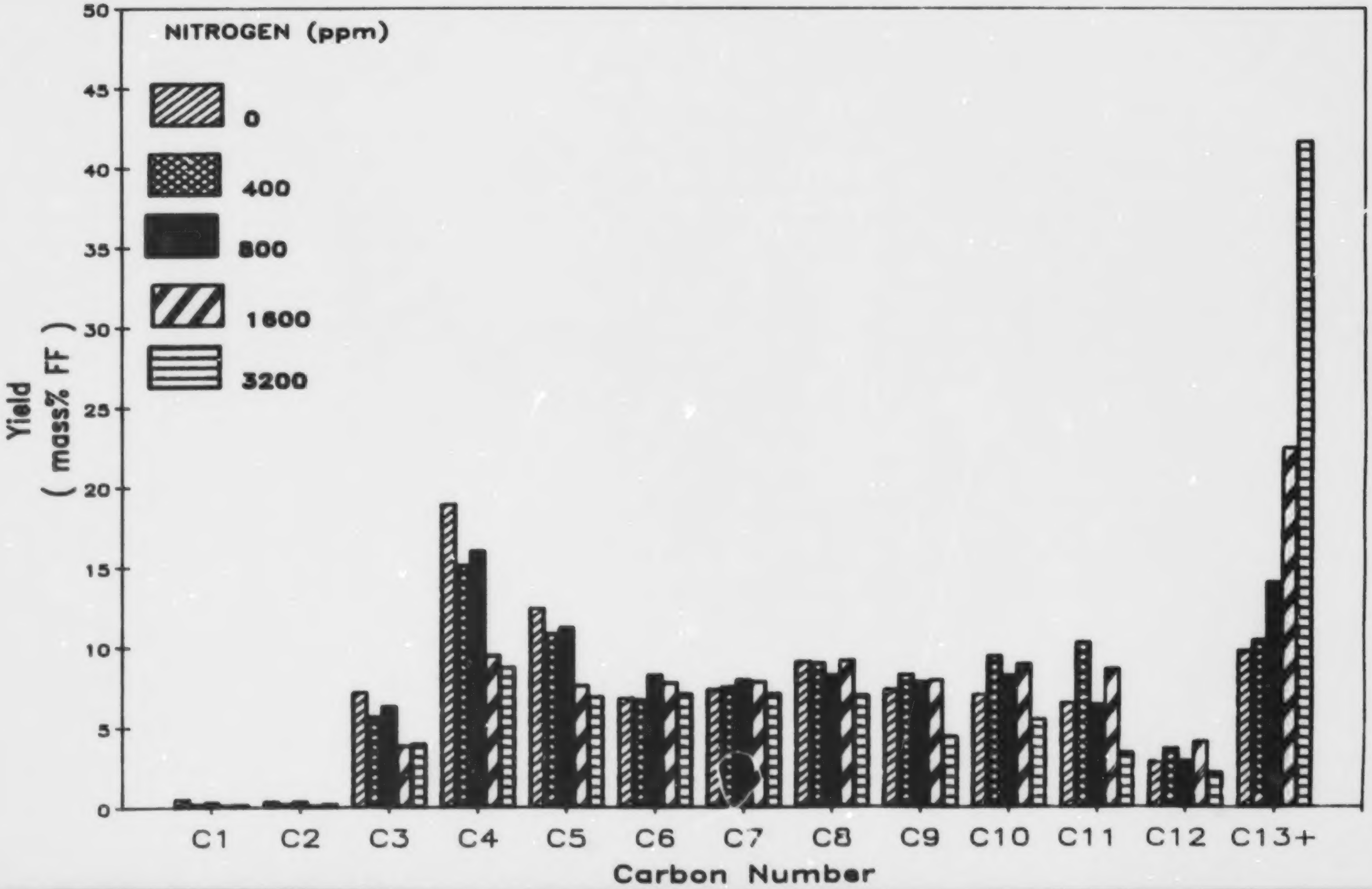


Figure 3.5.7 Effects of Nitrogen Poisoning

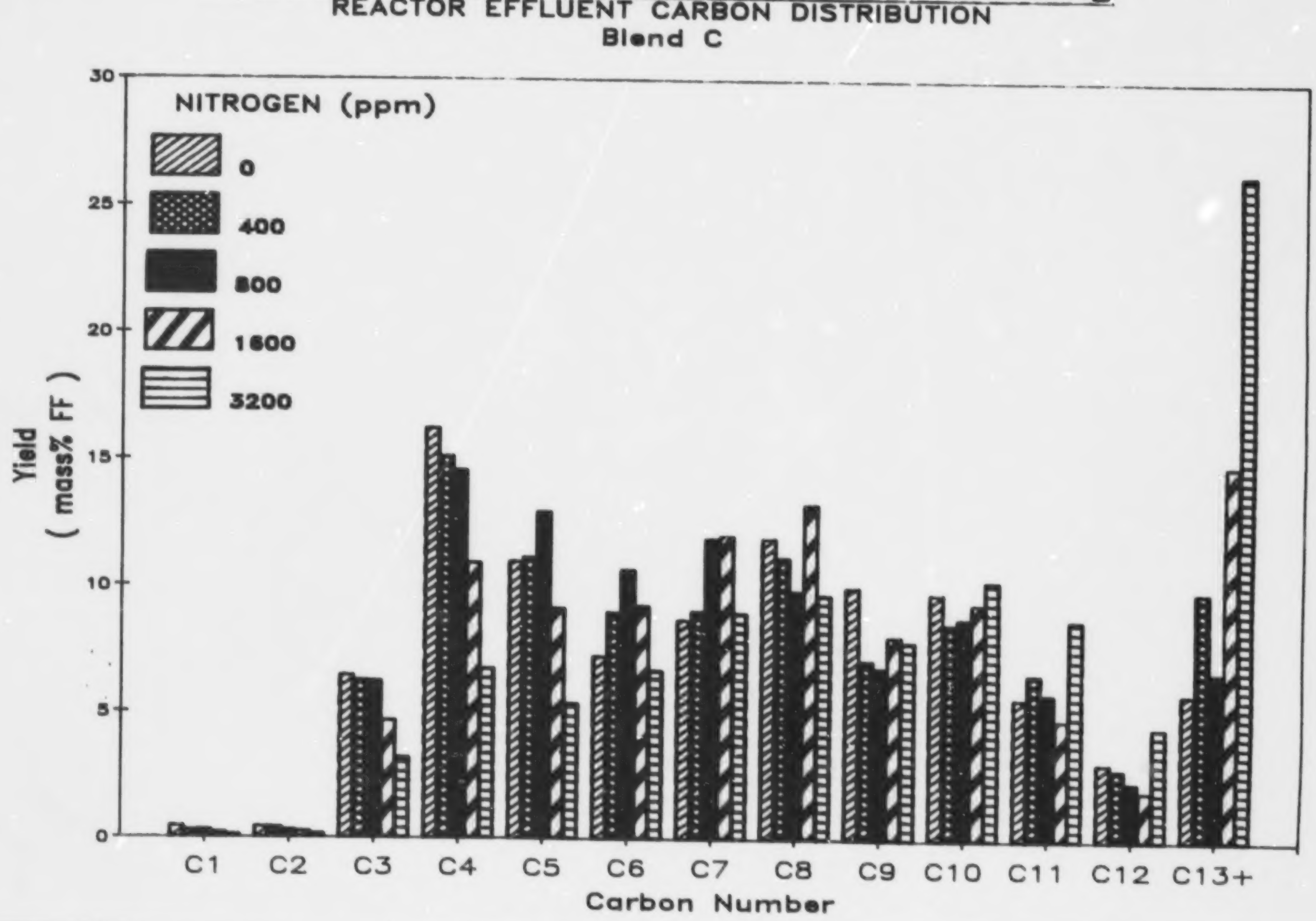


Figure 3.8.1

Key Component Blends & Synergistic Effects

Cracking Patterns for Blend A

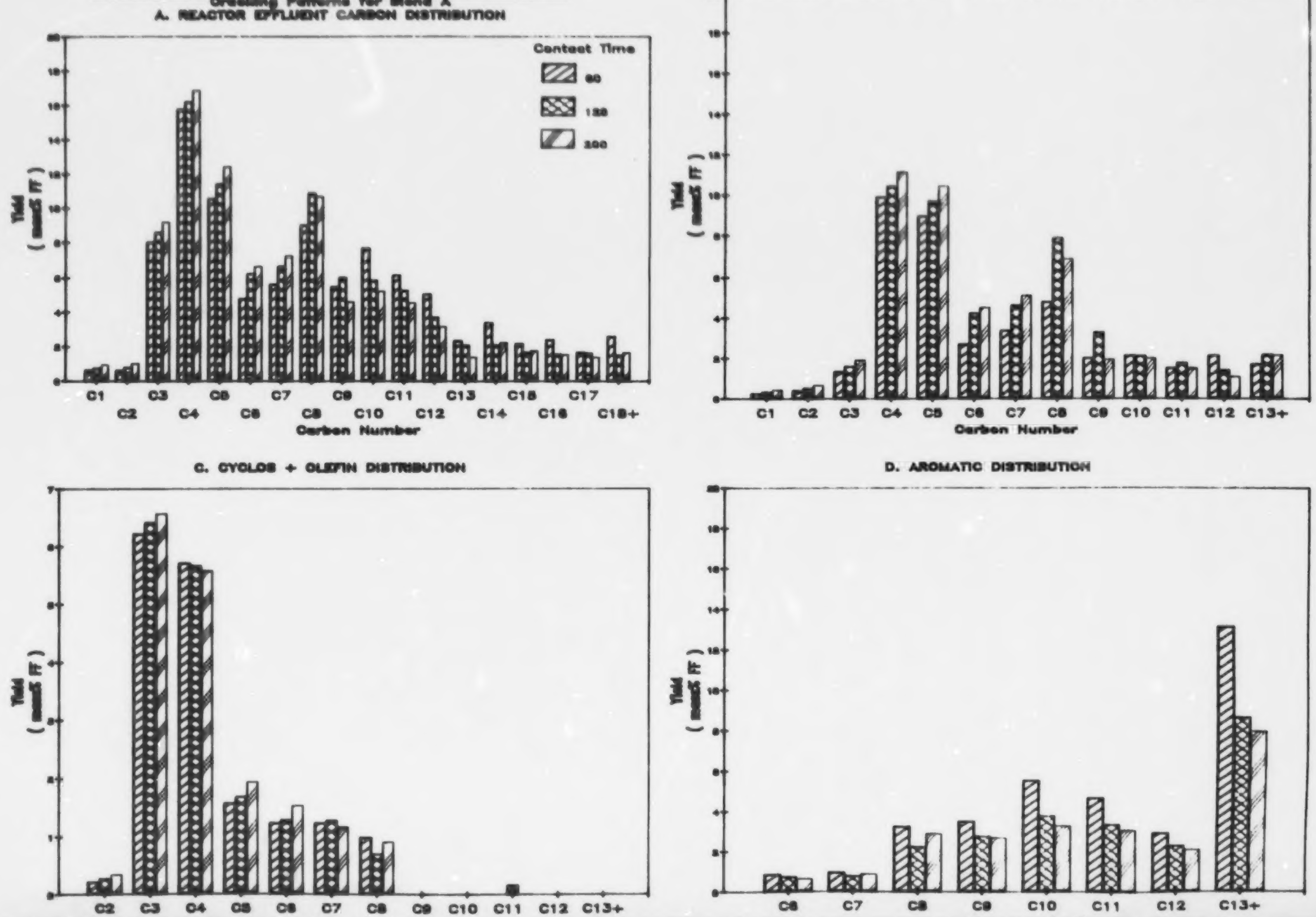


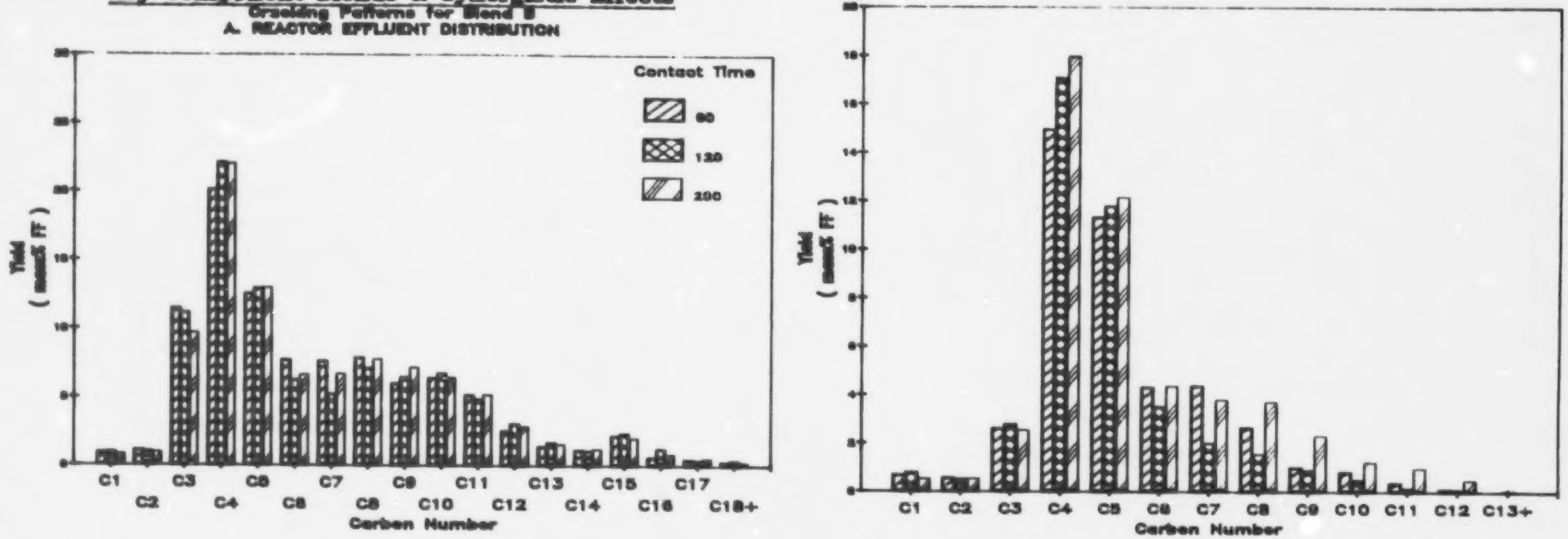
Figure 3.6.2

Key Component Blends & Synergistic Effects

Cracking Patterns for Blend 3

A. REACTOR EFFLUENT DISTRIBUTION

B. PARAFFIN DISTRIBUTION



C. CYCLOS + OLEFIN DISTRIBUTION

D. AROMATIC DISTRIBUTION

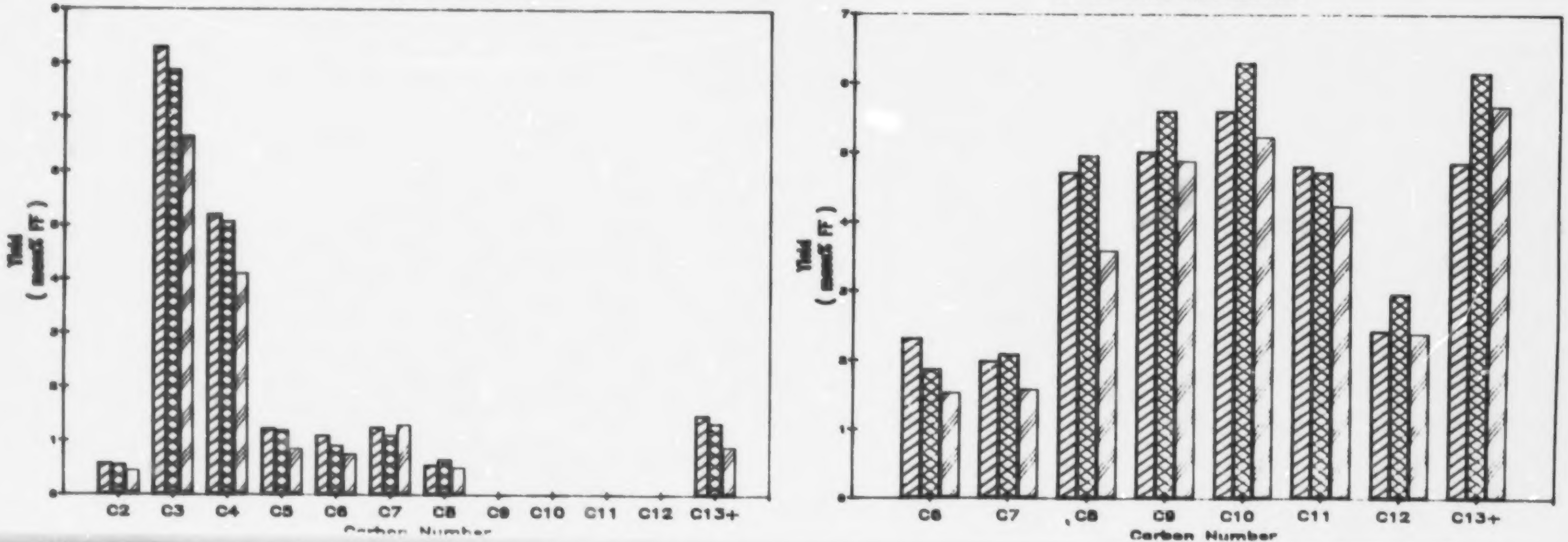


Figure 3.5.3

Key Component Blends & Synergistic Effects

Cracking Patterns for Blend C

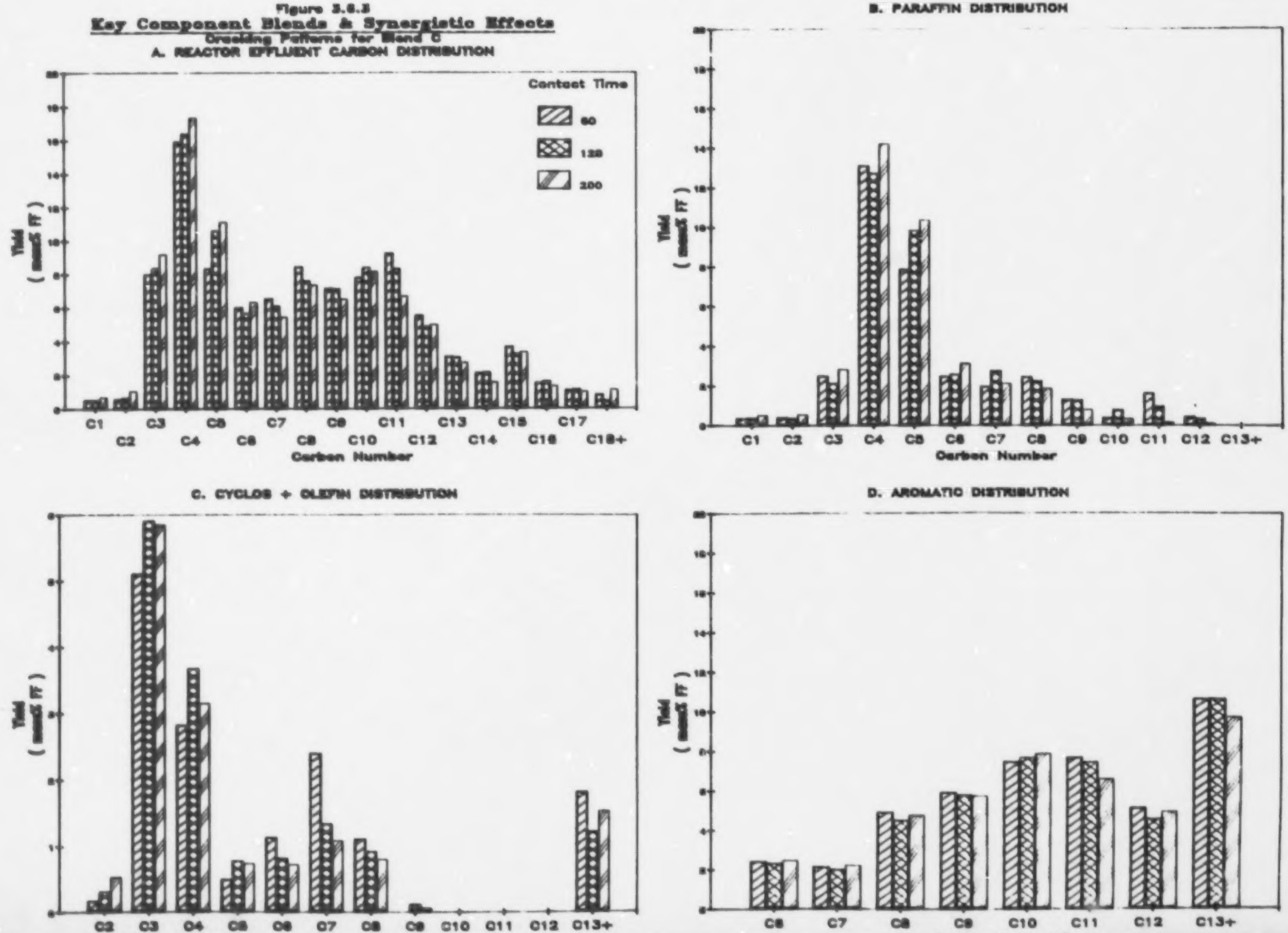


Figure 3.7.1 Effects of Residual Coke - Blend A

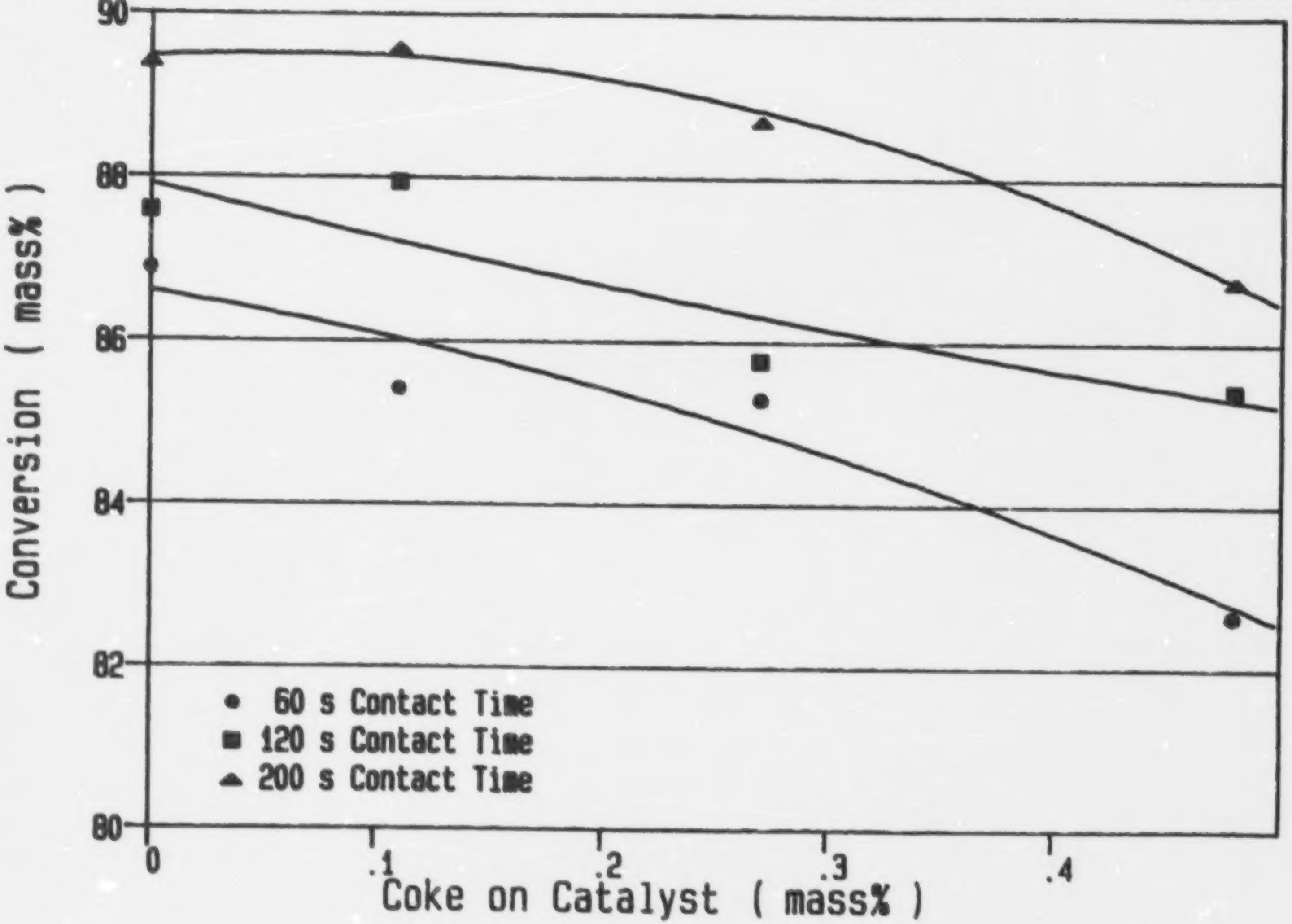


Figure 3.7.2 Effects of Residual Coke - Blend B

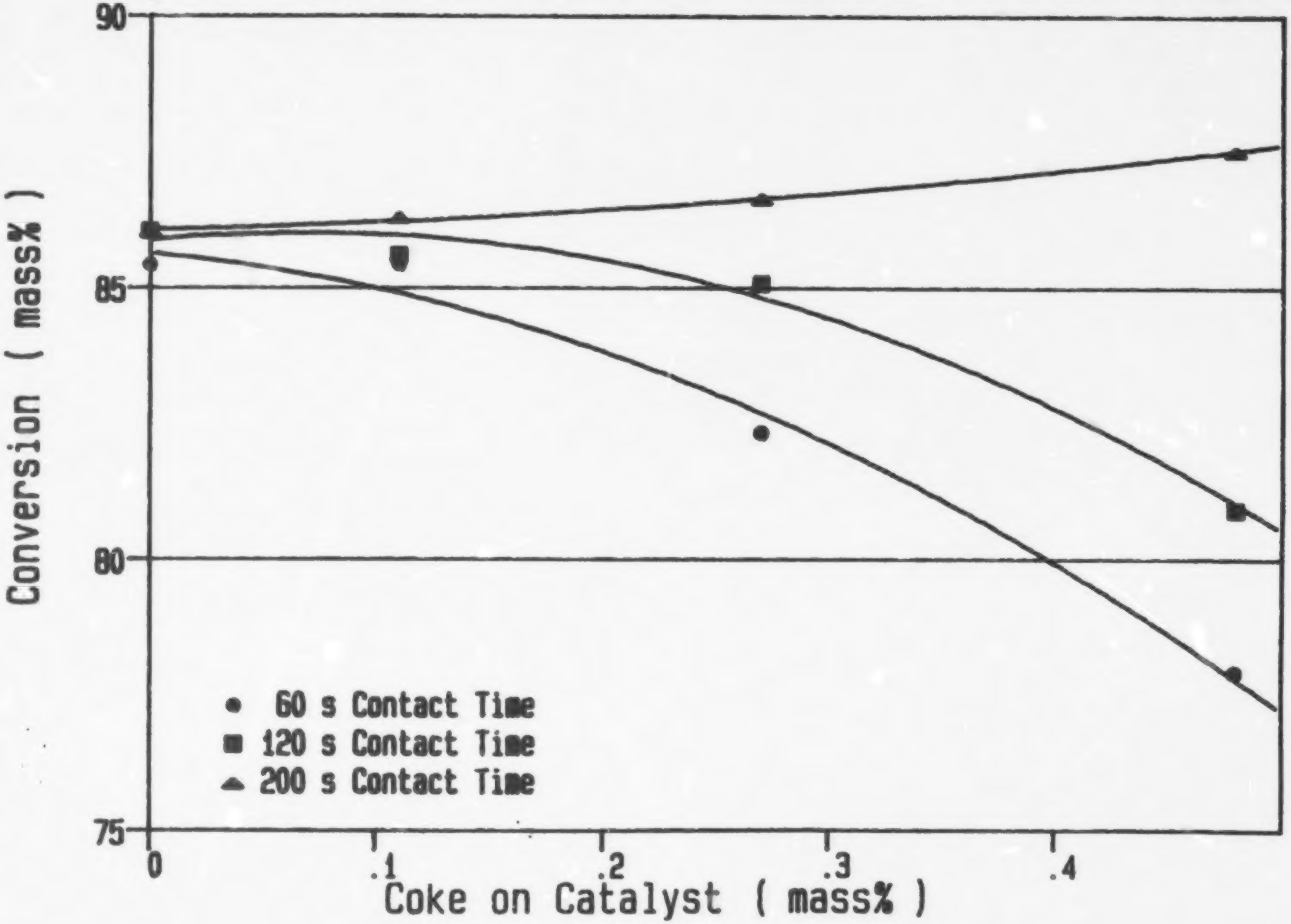


Figure 3.7.3 Effects of Residual Coke - Blend C

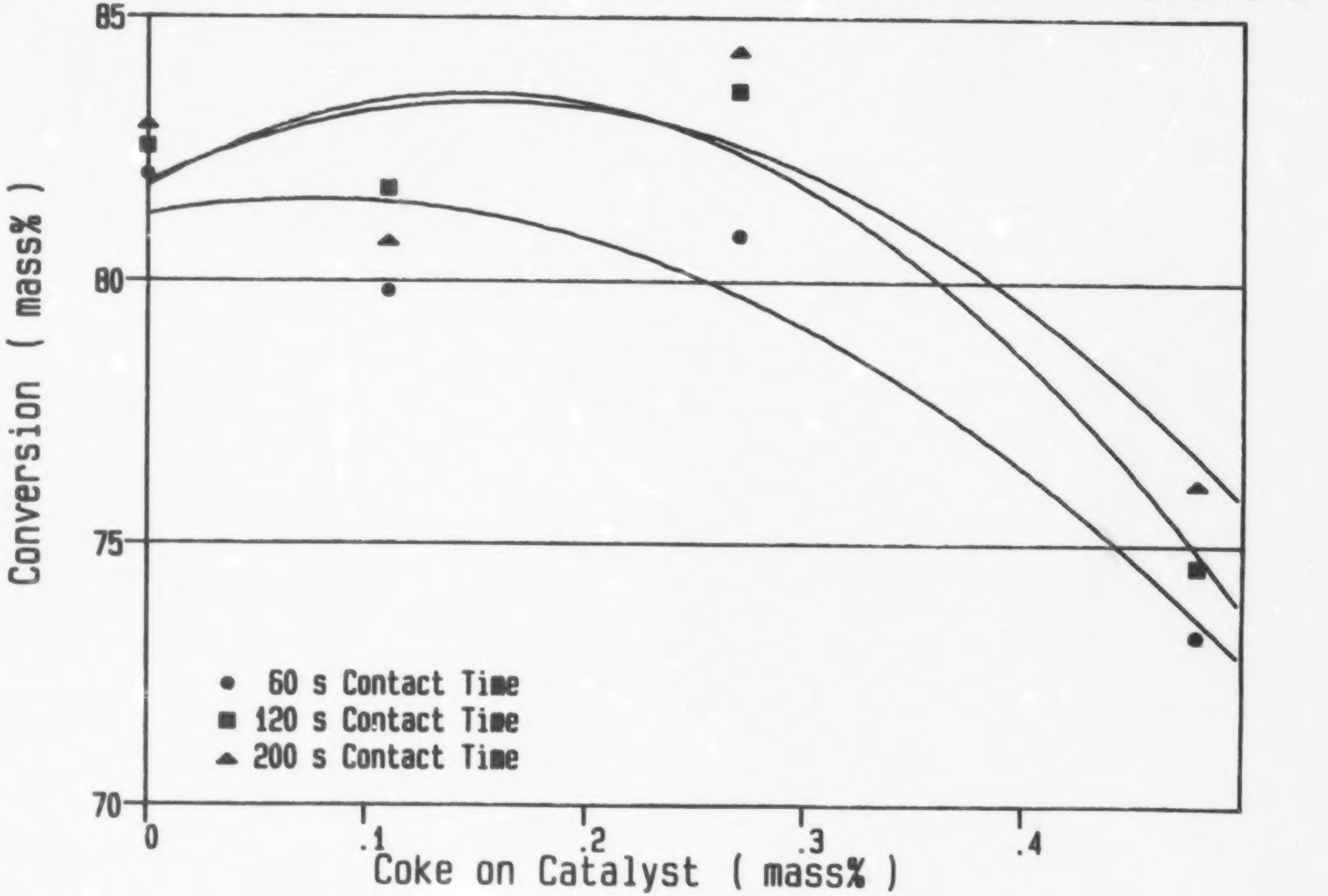


Figure 3.7.4 Effects of Residual Coke - Feedstock

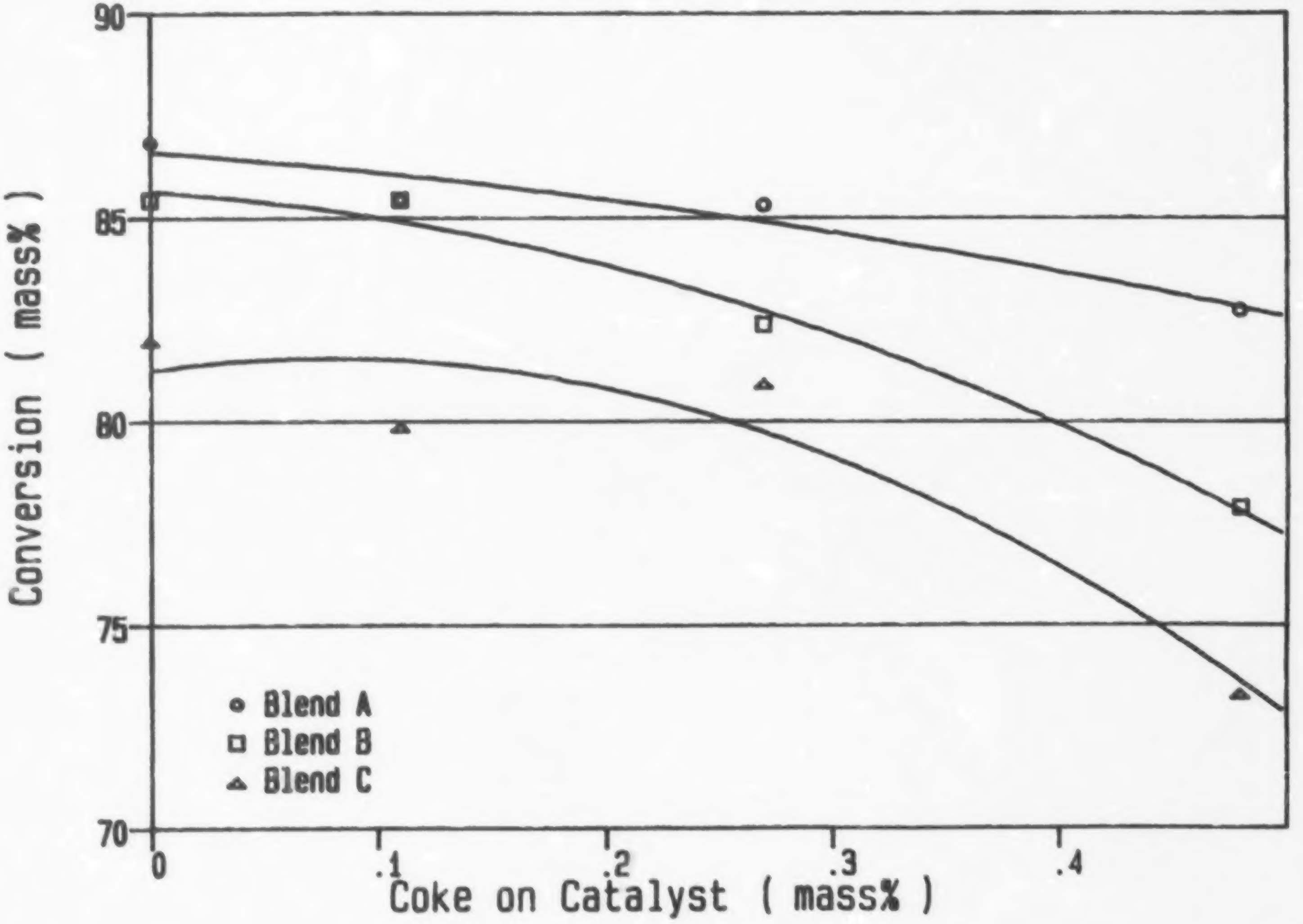


Figure 3.7.5 Effects of Residual Coke - Gasoline

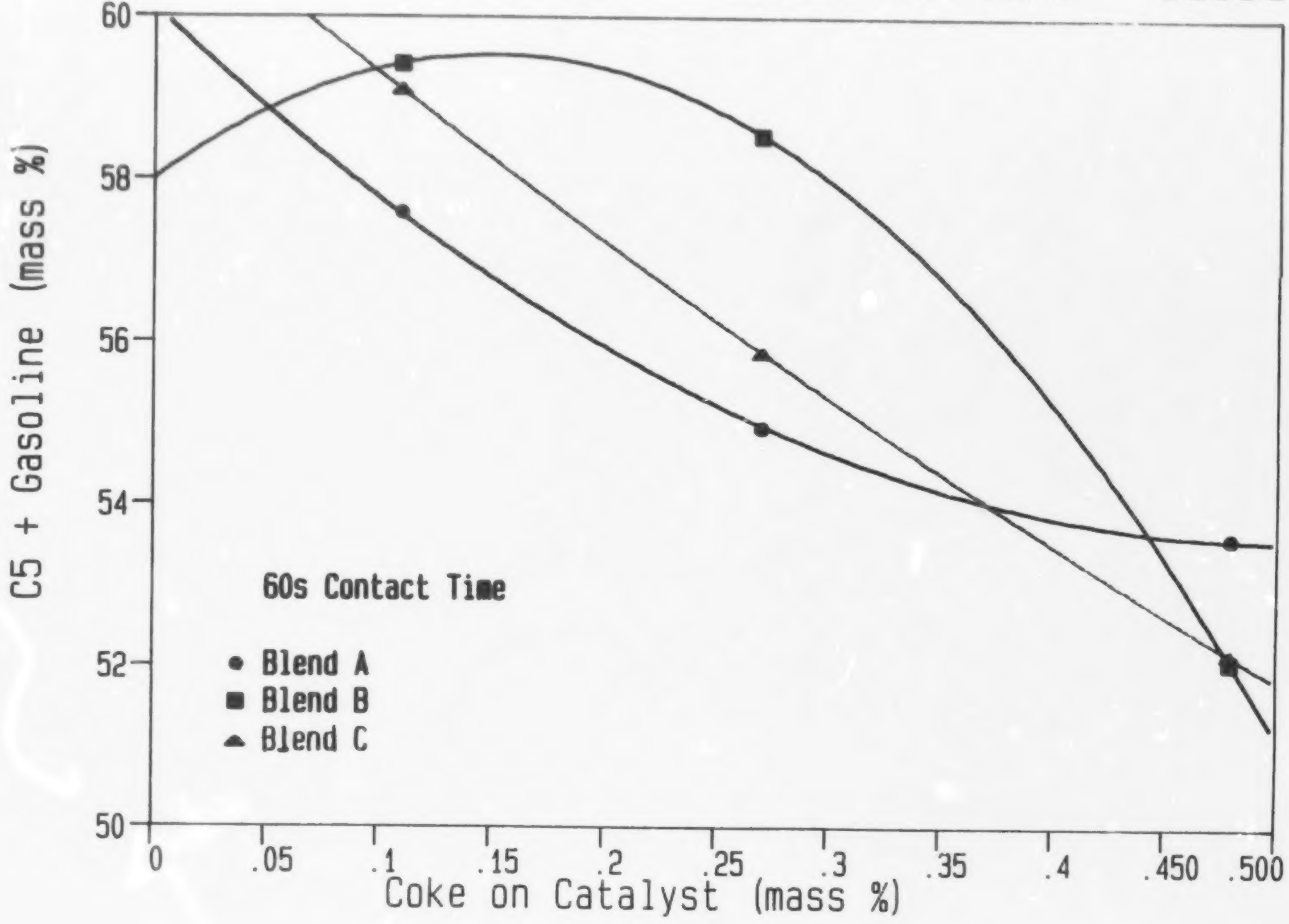


Figure 3.7.6 Effects of Residual Coke

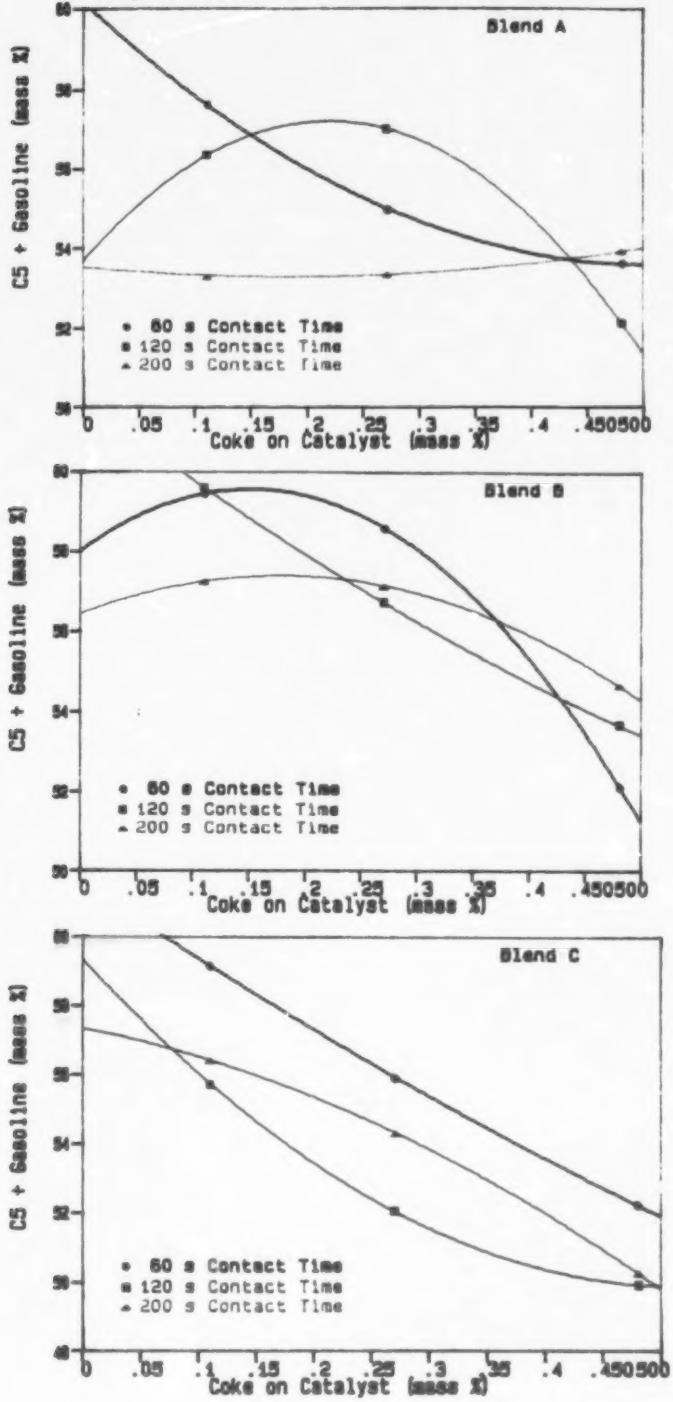


Figure 3.7.7

Effects of Residual Catalyst Coke on Cracking Yields

Blend A

REACTOR EFFLUENT CARBON DISTRIBUTION

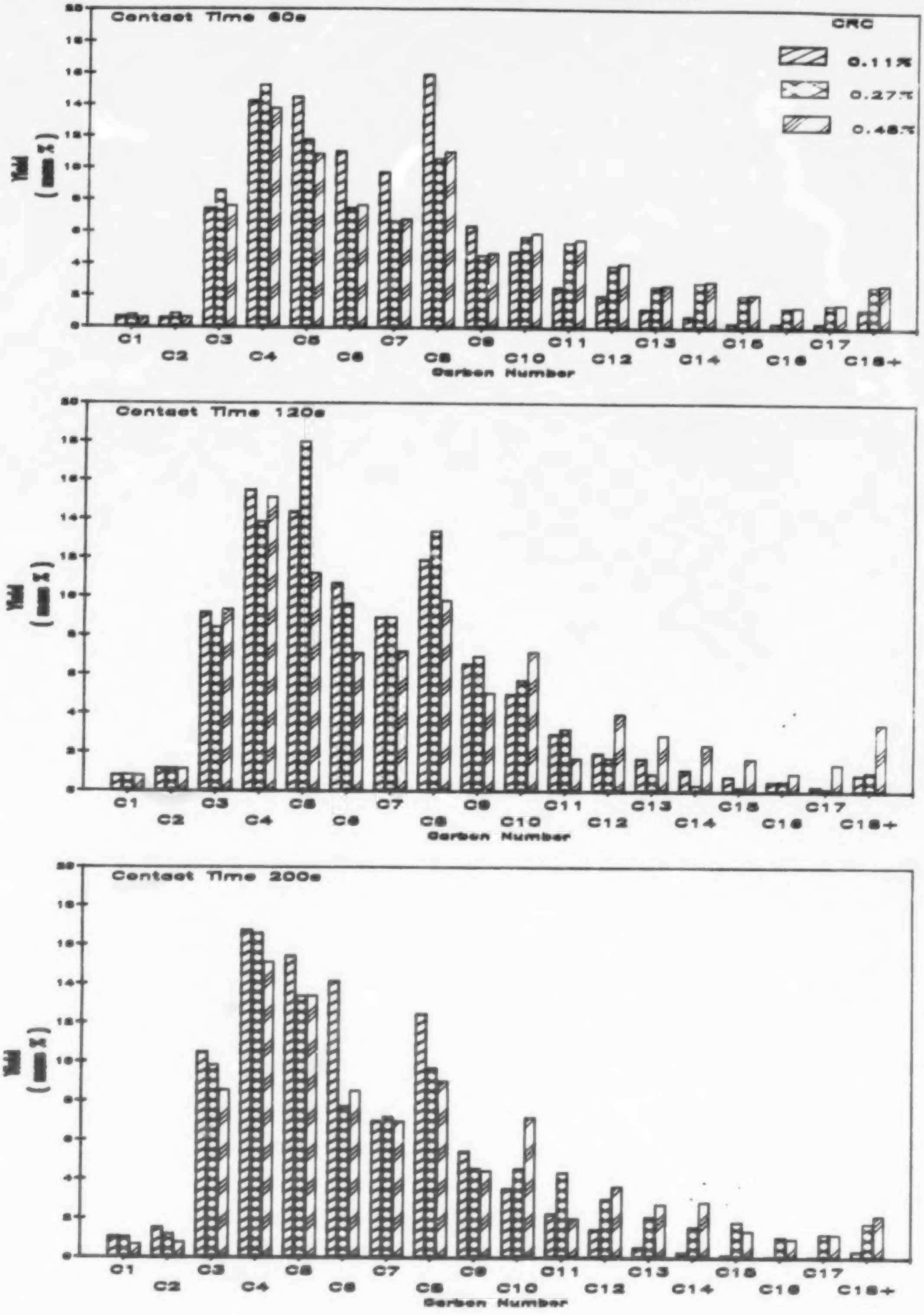


Figure 3.7.8

Effects of Residual Catalyst Coke on Cracking Yields

Blend A

PARAFFIN DISTRIBUTION

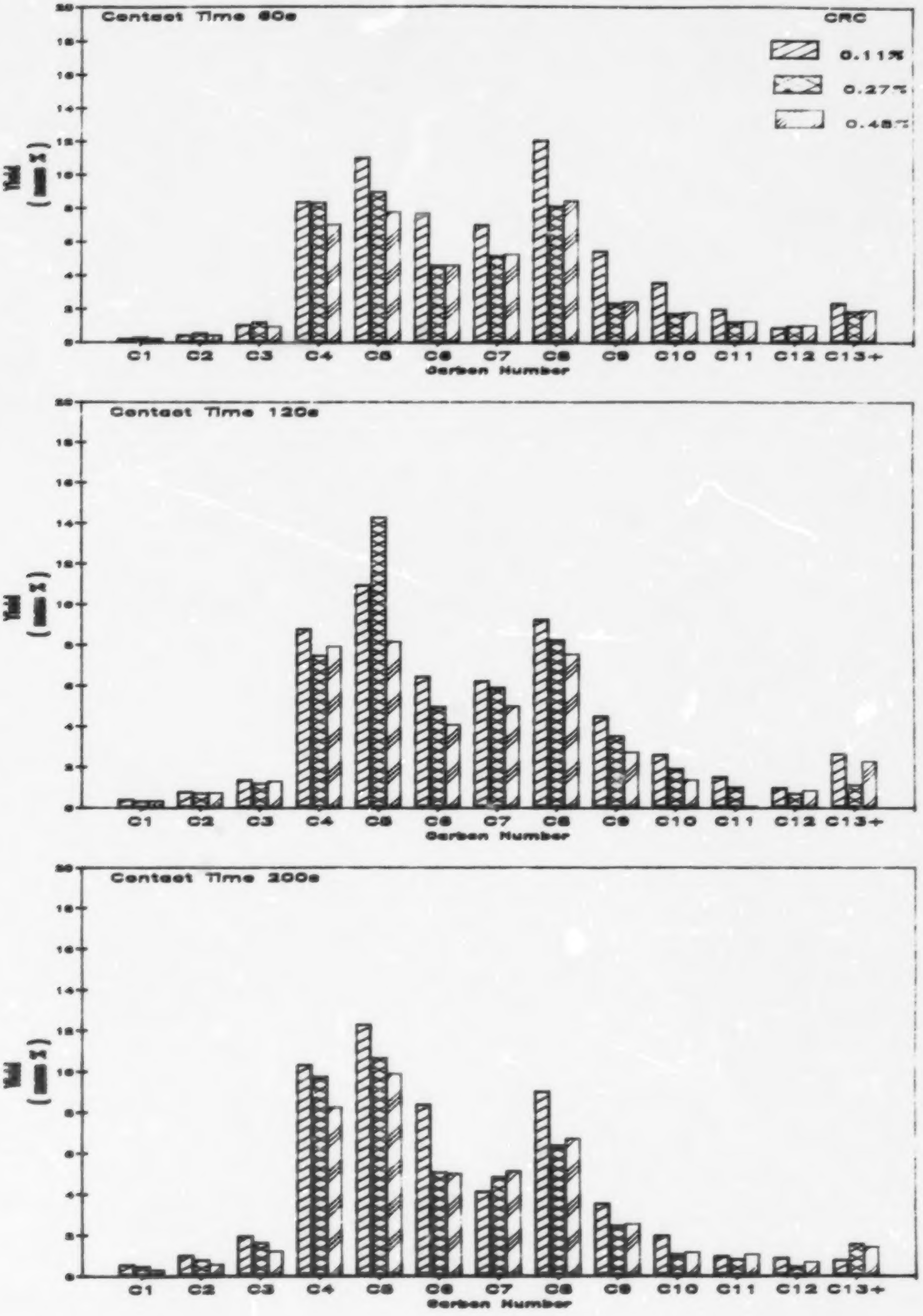


Figure 3.7.9

Effects of Residual Catalyst Coke on Cracking Yields

Blend A

CYCLOS + OLEFIN DISTRIBUTION

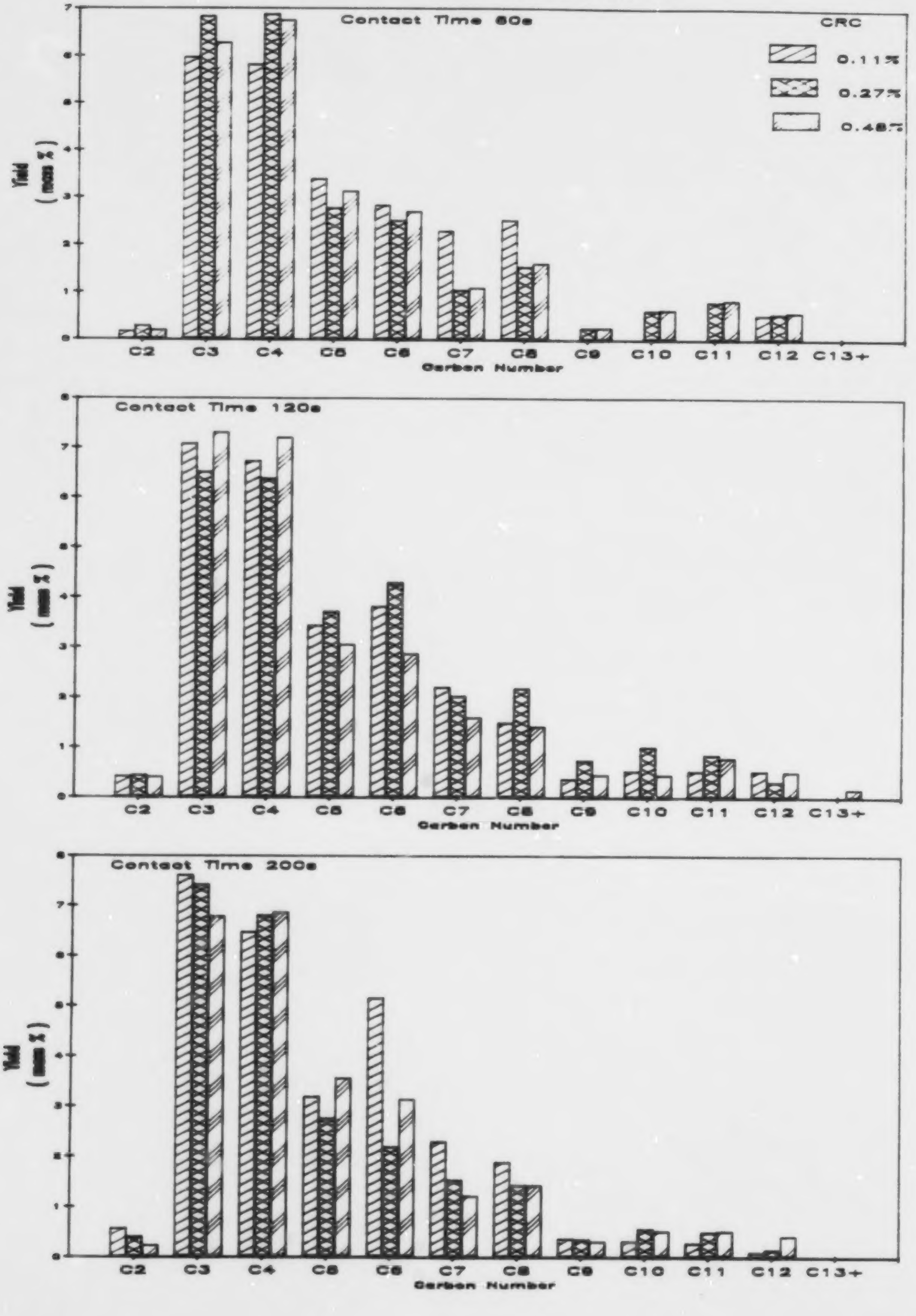


Figure 3.7.10

Effects of Residual Catalyst Coke on Cracking Yields

Blend A

AROMATIC DISTRIBUTION

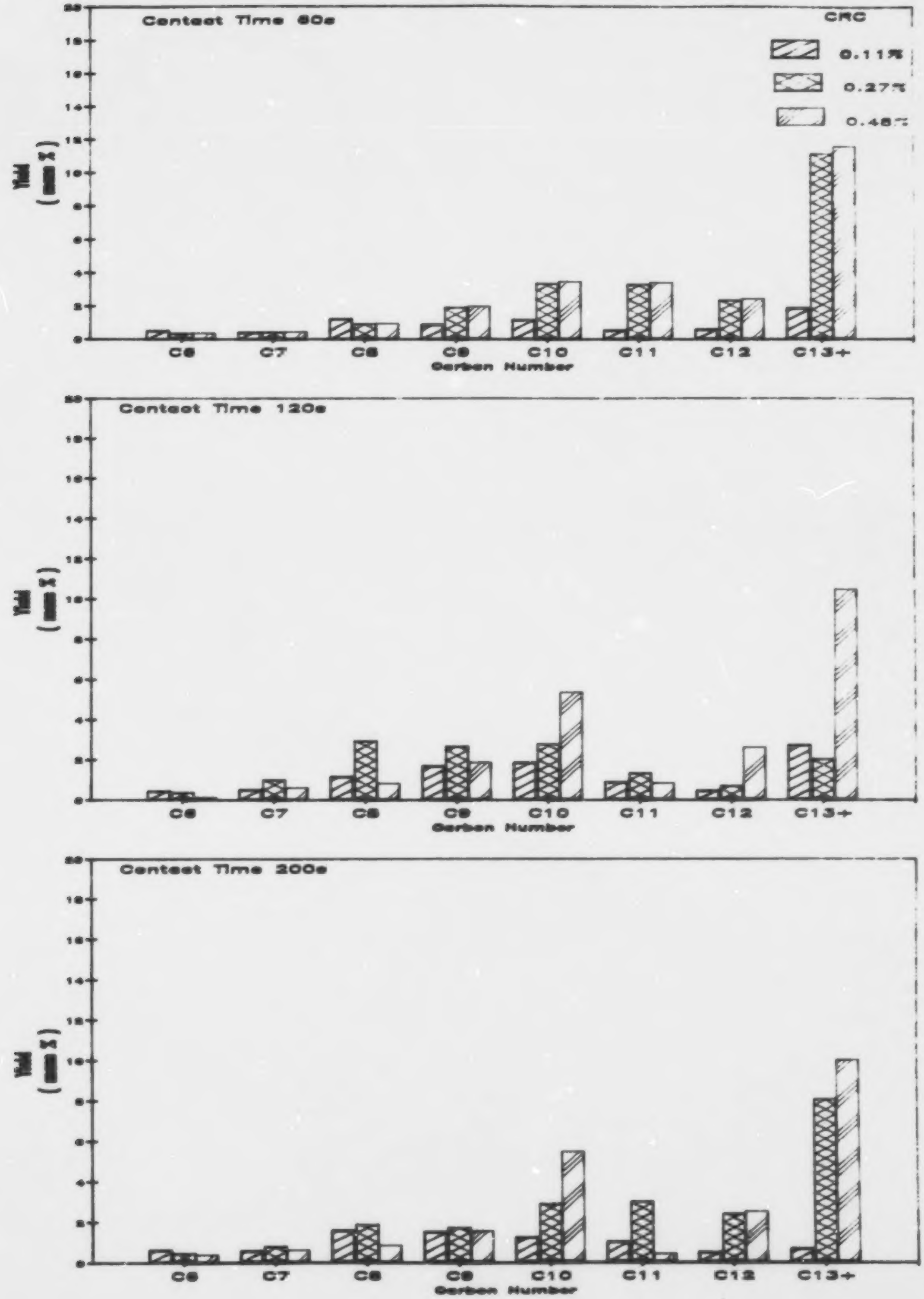


Figure 3.7.11

Effects of Residual Catalyst Coke on Cracking Yields

Blend B

REACTOR EFFLUENT CARBON DISTRIBUTION

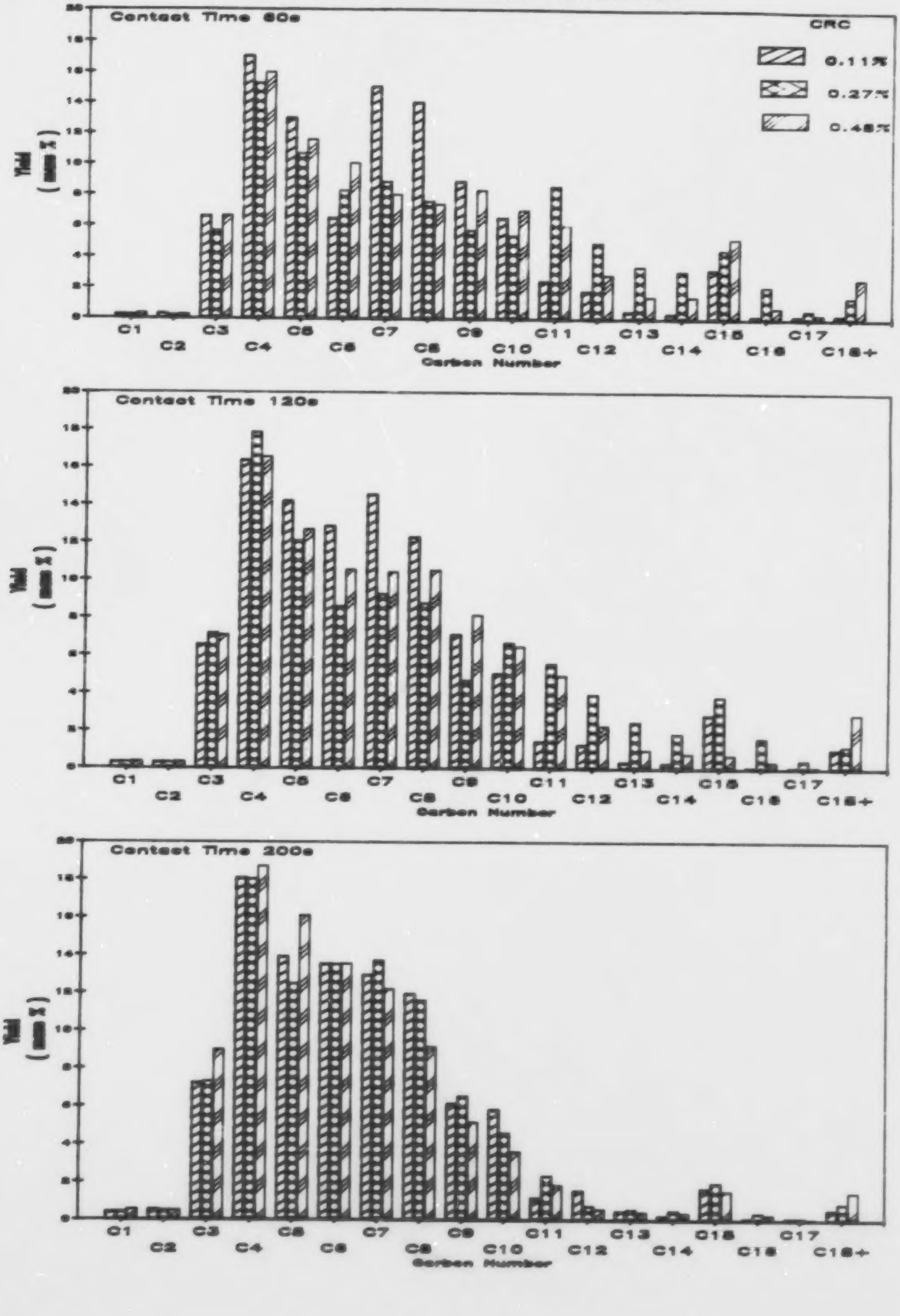


Figure 3.7.12

Effects of Residual Catalyst Coke on Cracking Yields

Blend B

PARAFFIN DISTRIBUTION

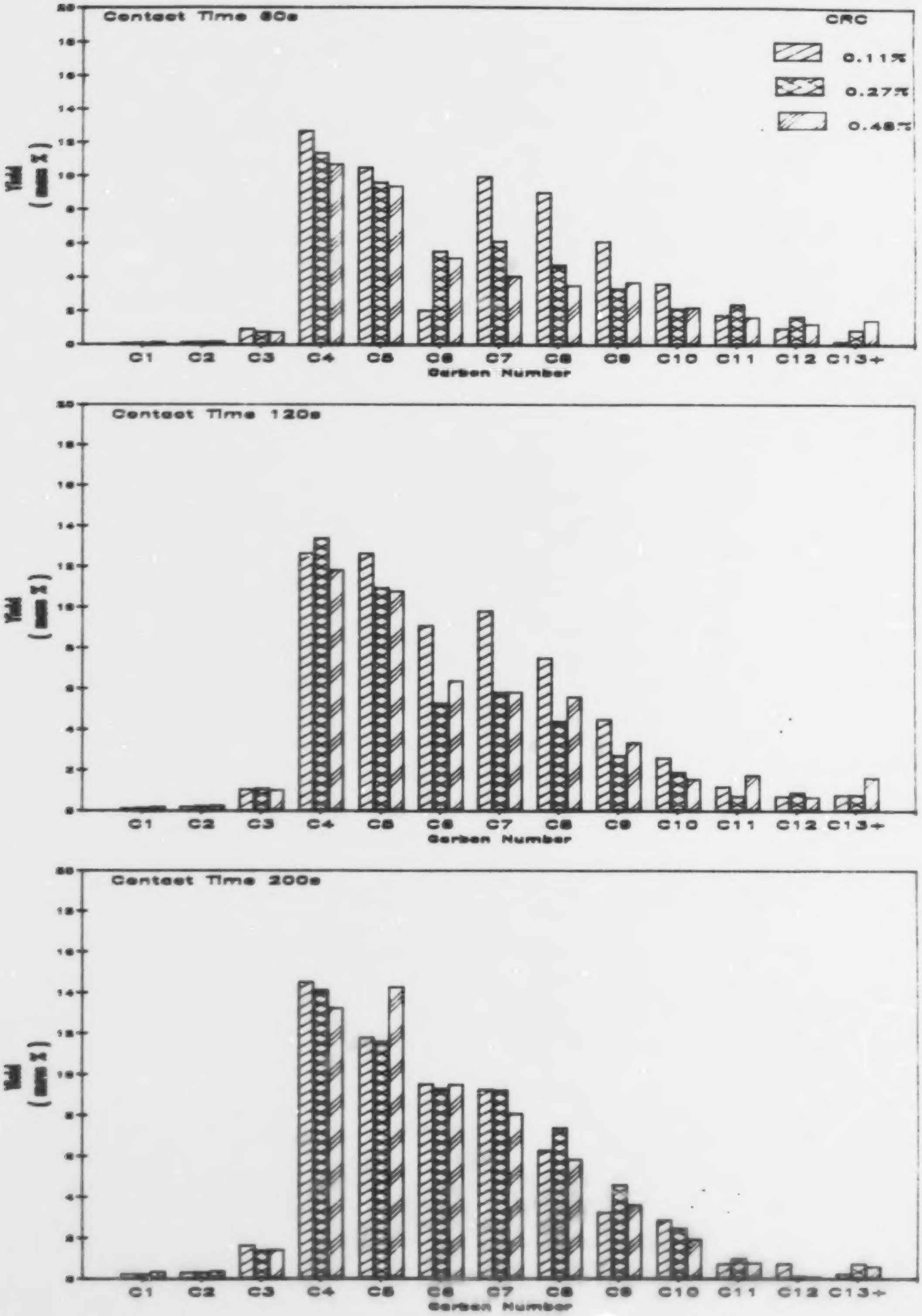


Figure 3.7.13

Effects of Residual Catalyst Coke on Cracking Yields

Blend B

CYCLOS + OLEFIN DISTRIBUTION

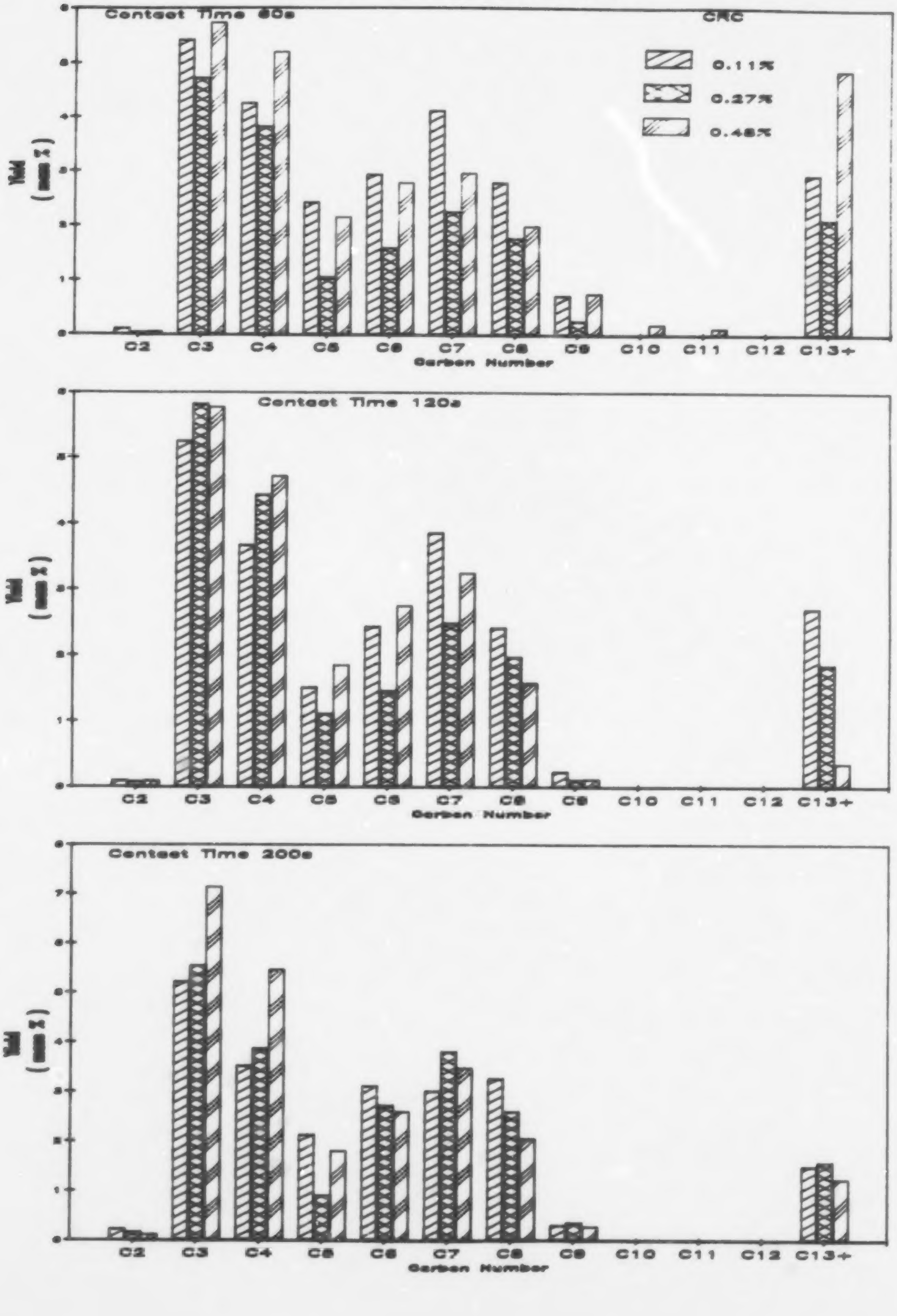


Figure 3.7.14

Effects of Residual Catalyst Coke on Cracking Yields

Blend 5

AROMATIC DISTRIBUTION

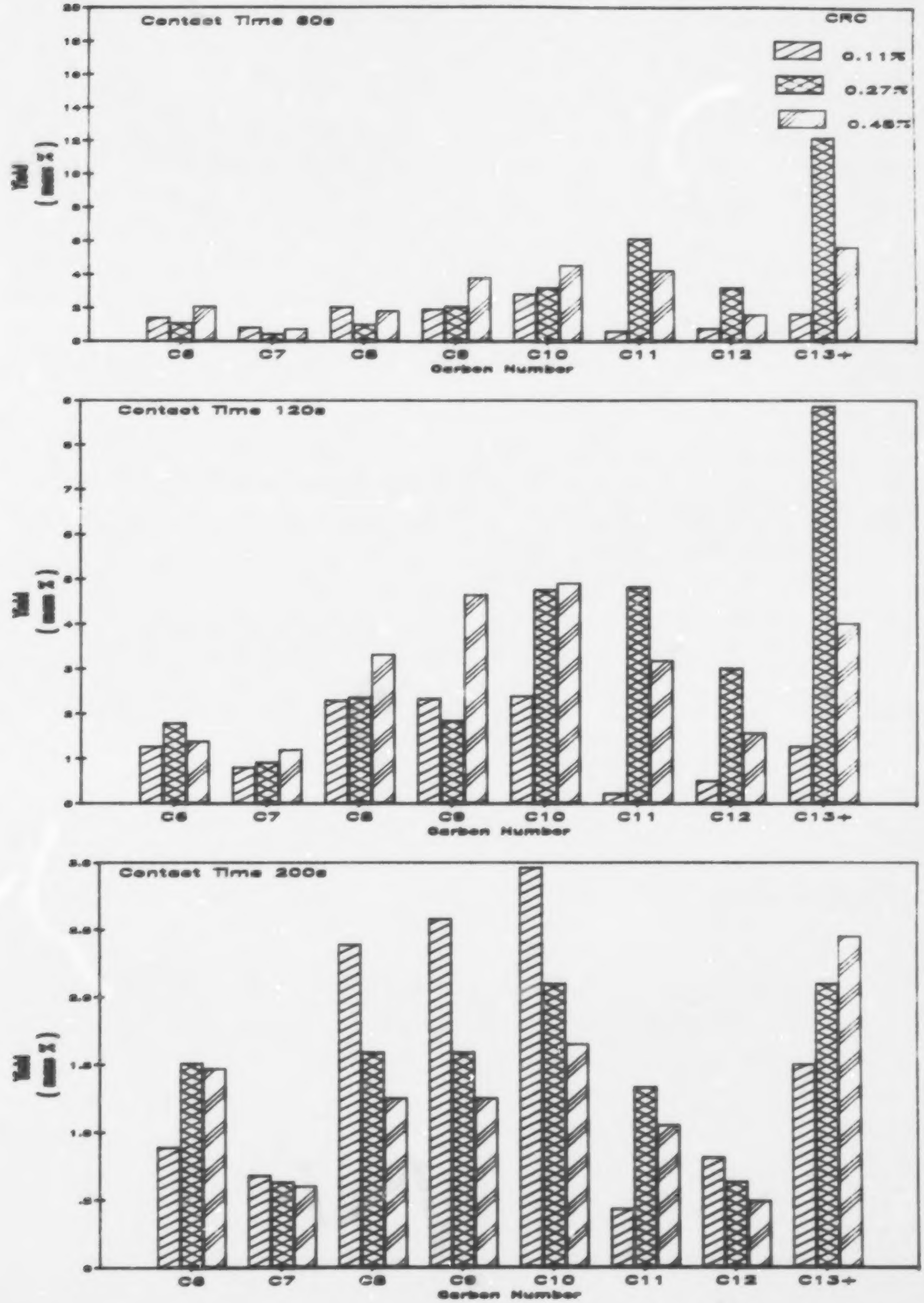


Figure 3.7.15

Effects of Residual Catalyst Coke on Cracking Yields

Blend C

REACTOR EFFLUENT CARBON DISTRIBUTION

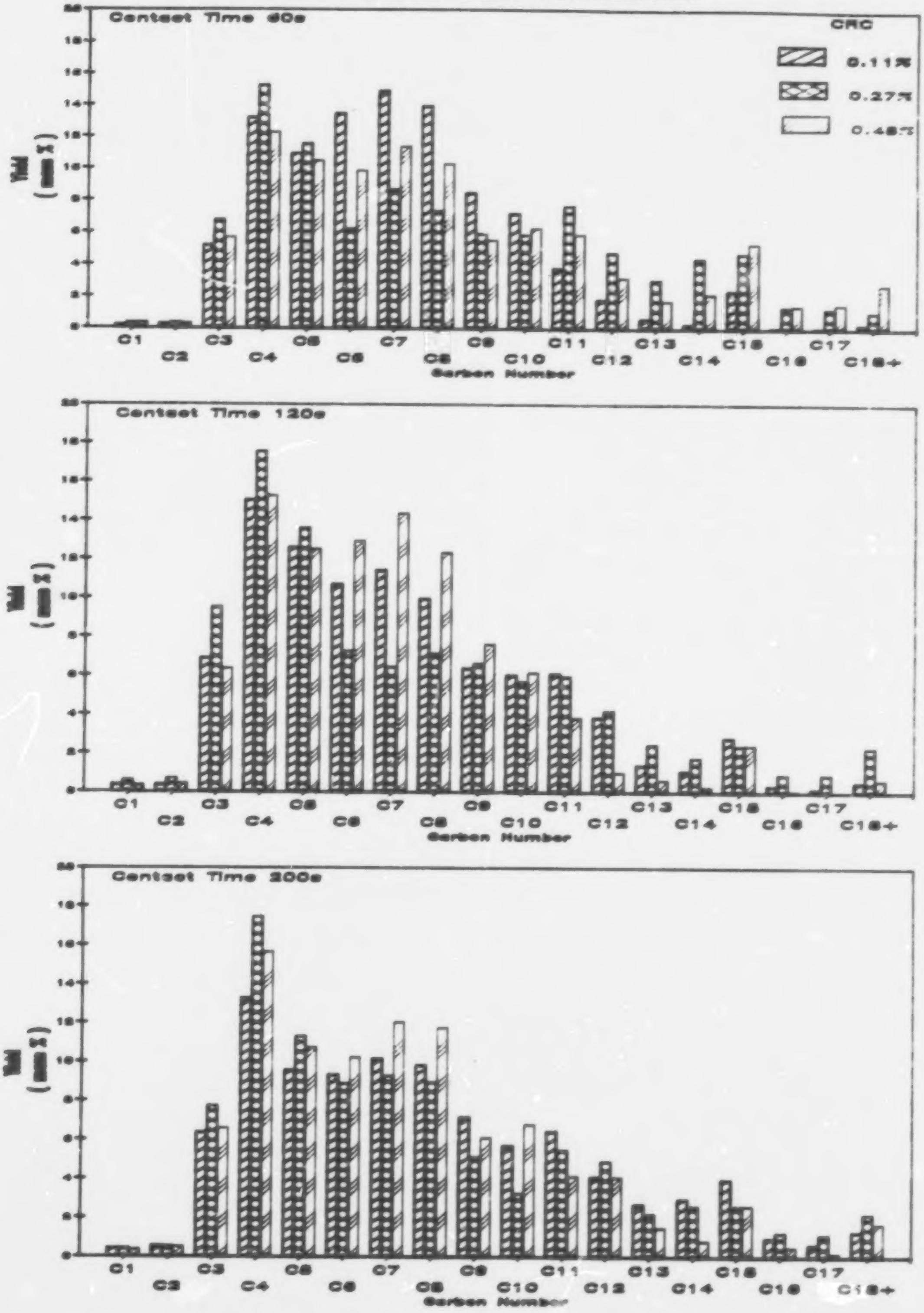


Figure 3.7.16

Effects of Residual Catalyst Coke on Cracking Yields

Blend C

PARAFFIN DISTRIBUTION

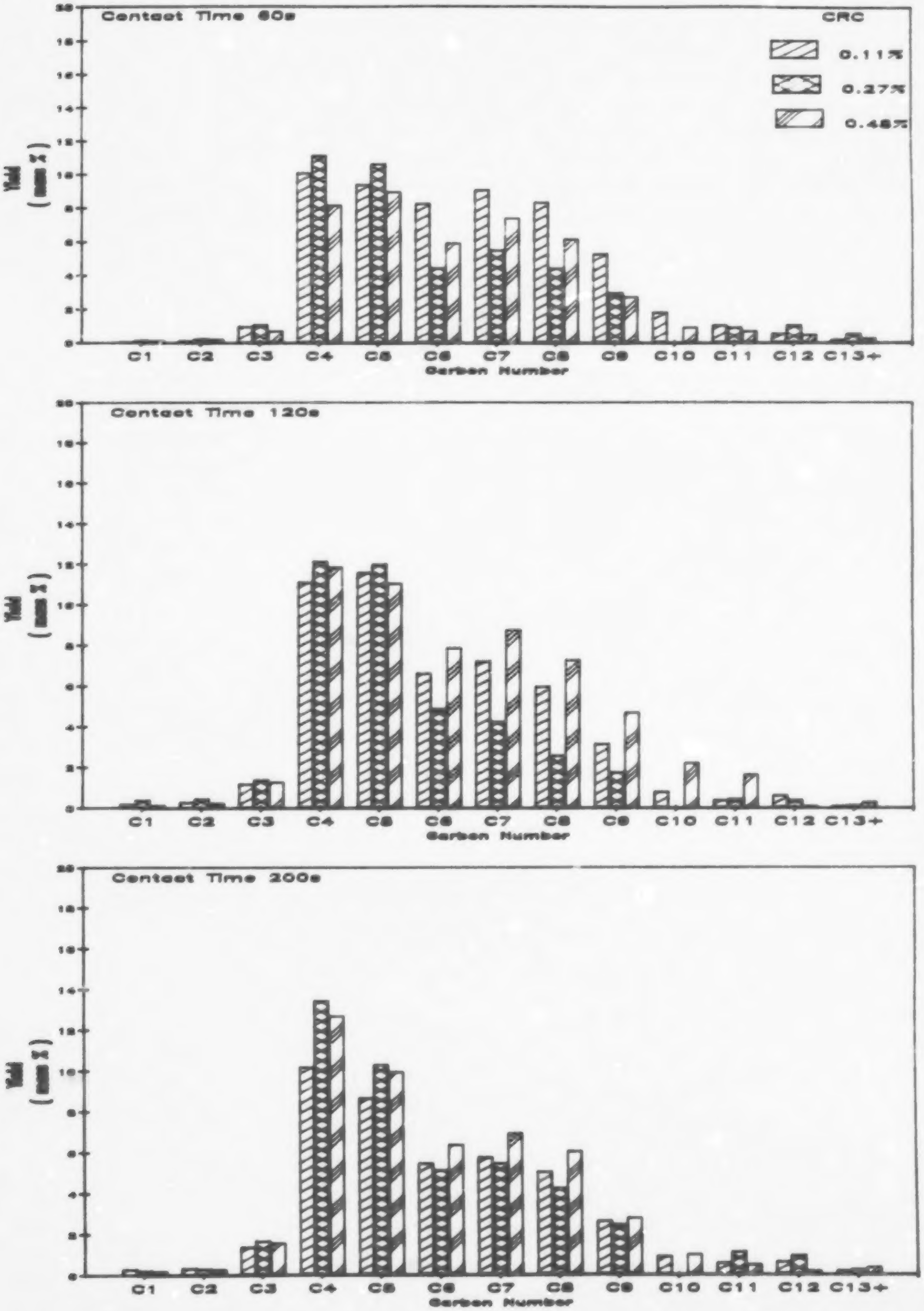


Figure 3.7.17

Effects of Residual Catalyst Coke on Cracking Yields

Blend C

CYCLOS + OLEFIN DISTRIBUTION

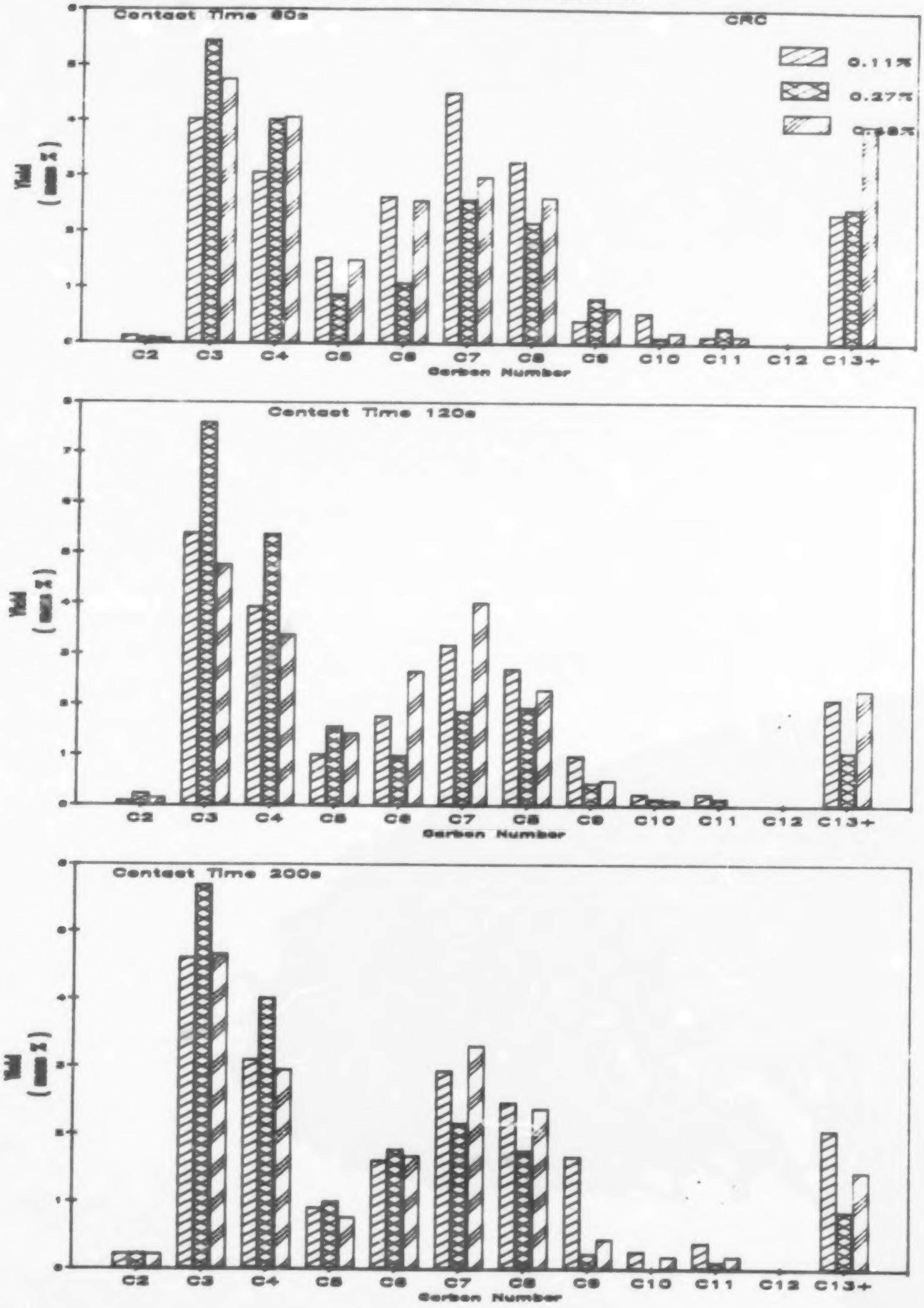


Figure 3.7.18

Effects of Residual Catalyst Coke on Cracking Yields

Blend C

AROMATIC DISTRIBUTION

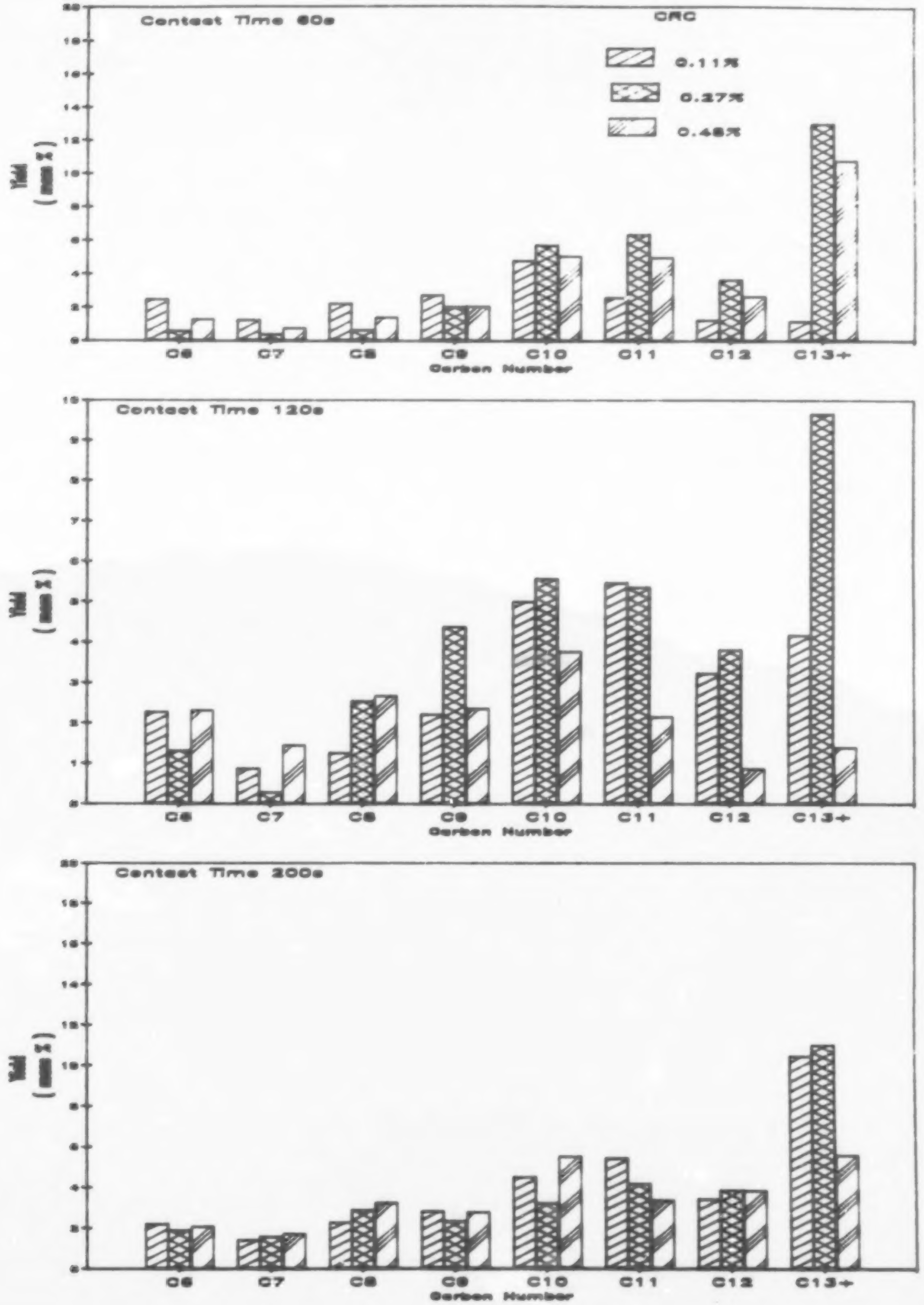


Figure 3.9.1 Effects of Nickel - Hydrogen

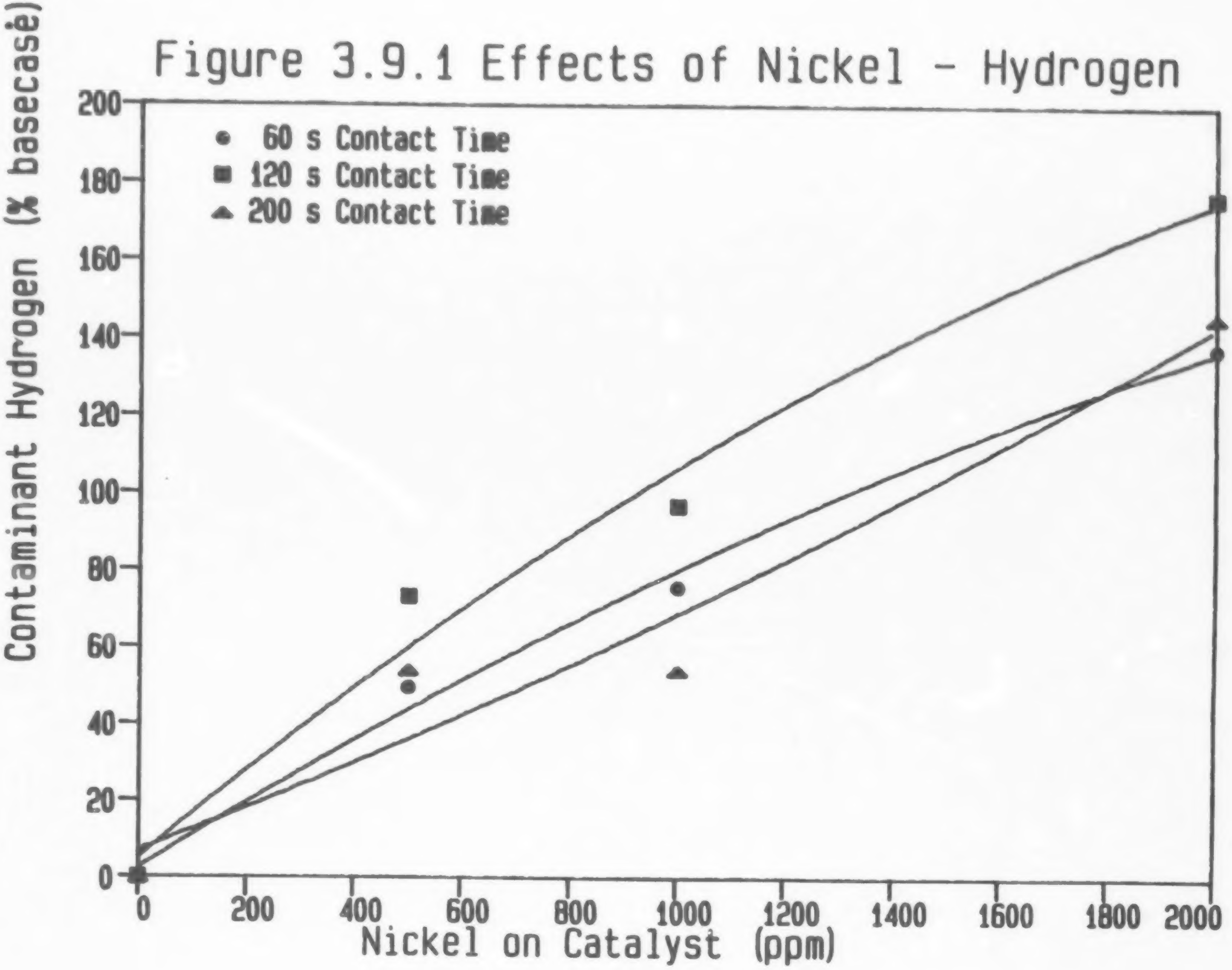


Figure 3.9.2 Effects of Nickel - Coke

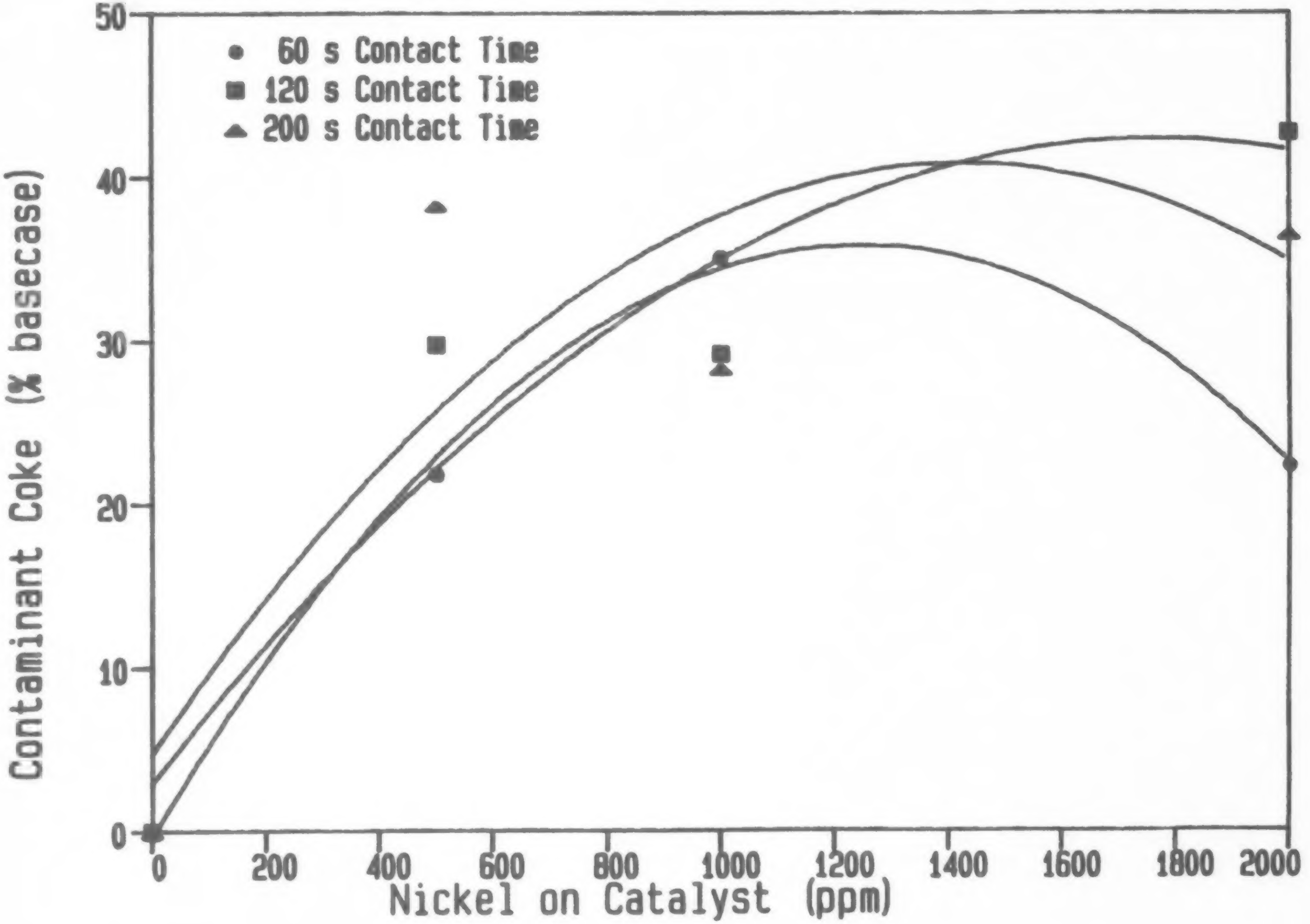


Figure 3.9.3 Effects of Nickel - Propene/Propane

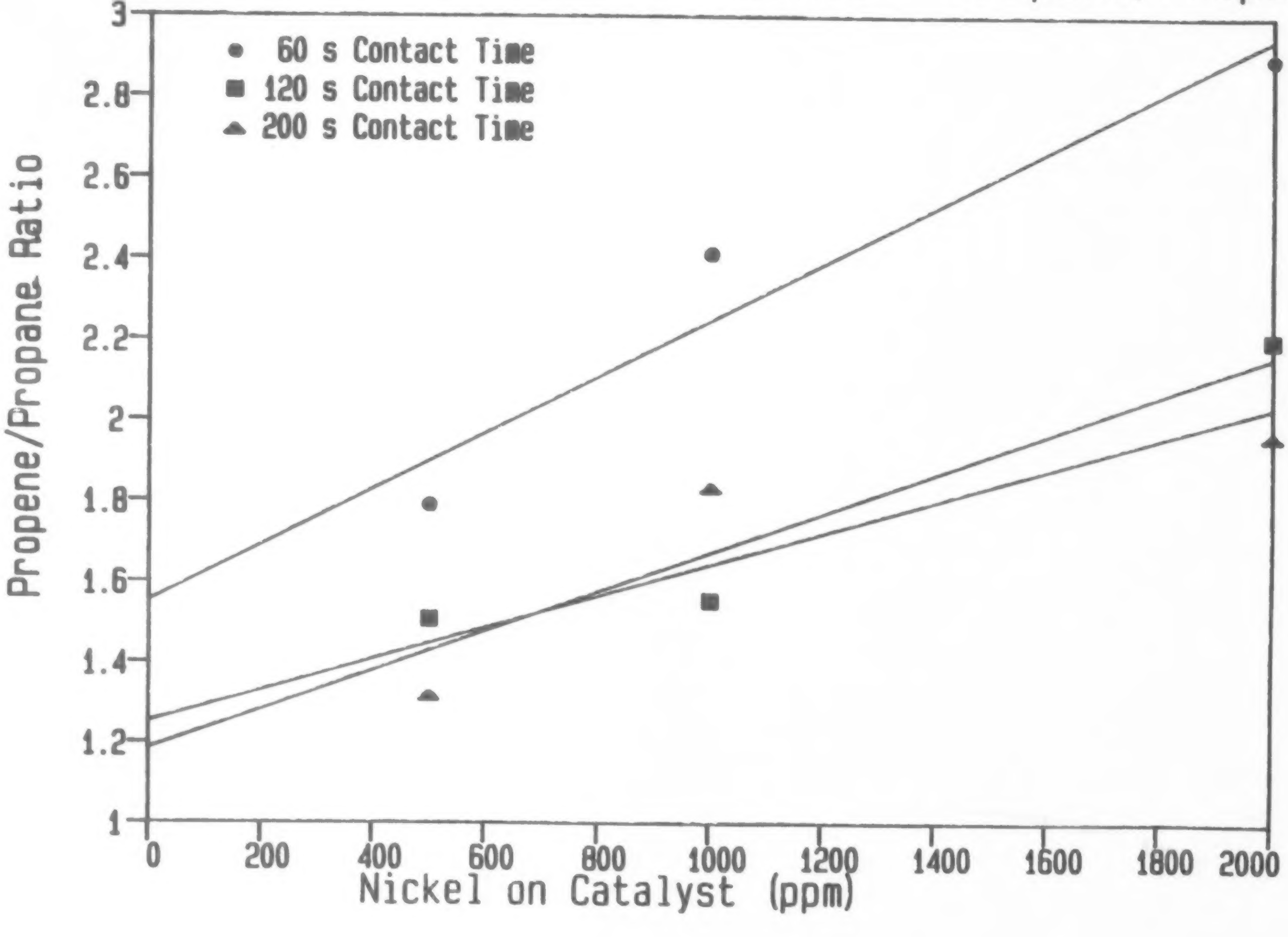


Figure 3.9.4 Effects of Metals on Gas Oil Cracking

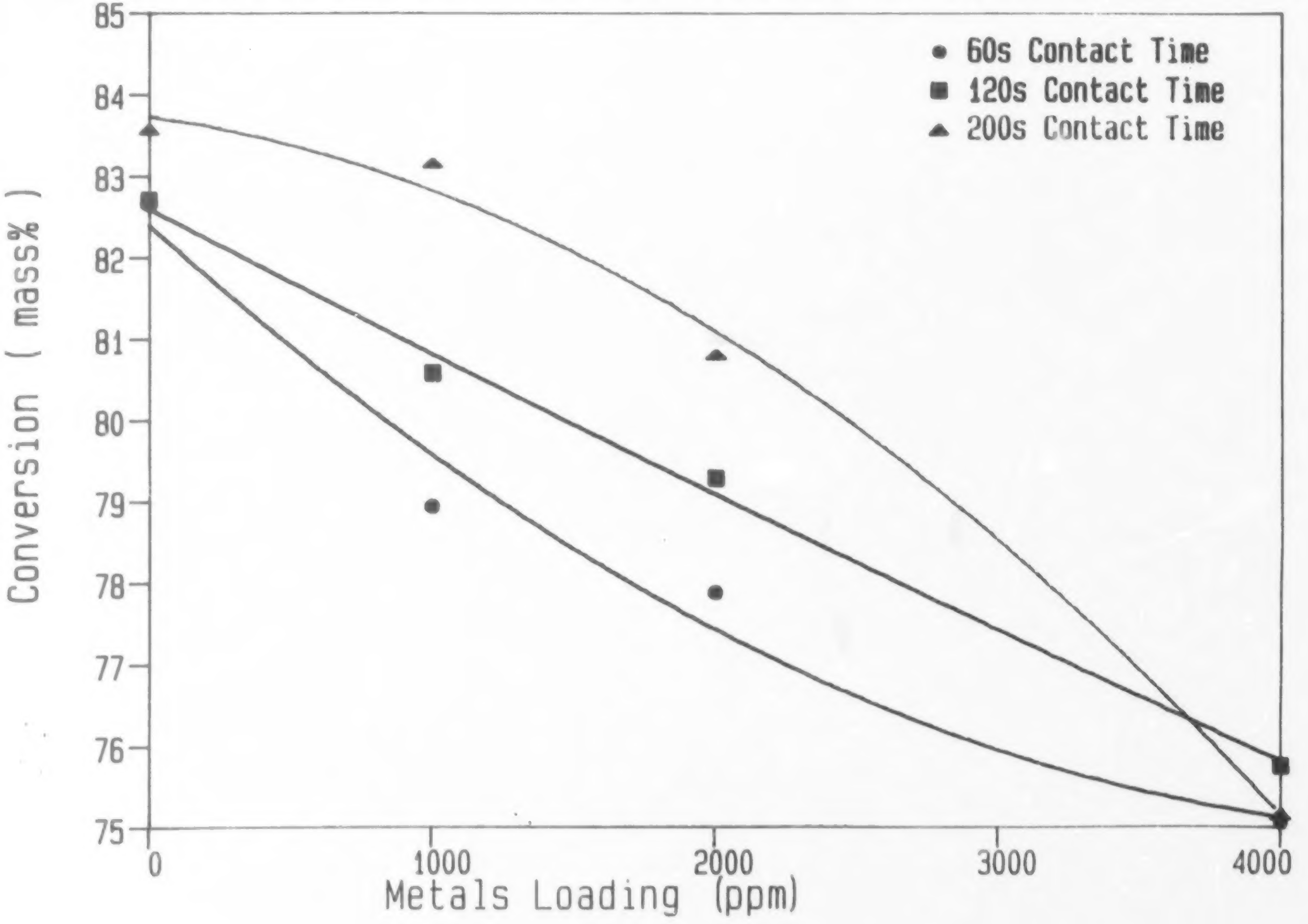


Figure 3.9.5 Effects of Metals on Gas Oil Cracking

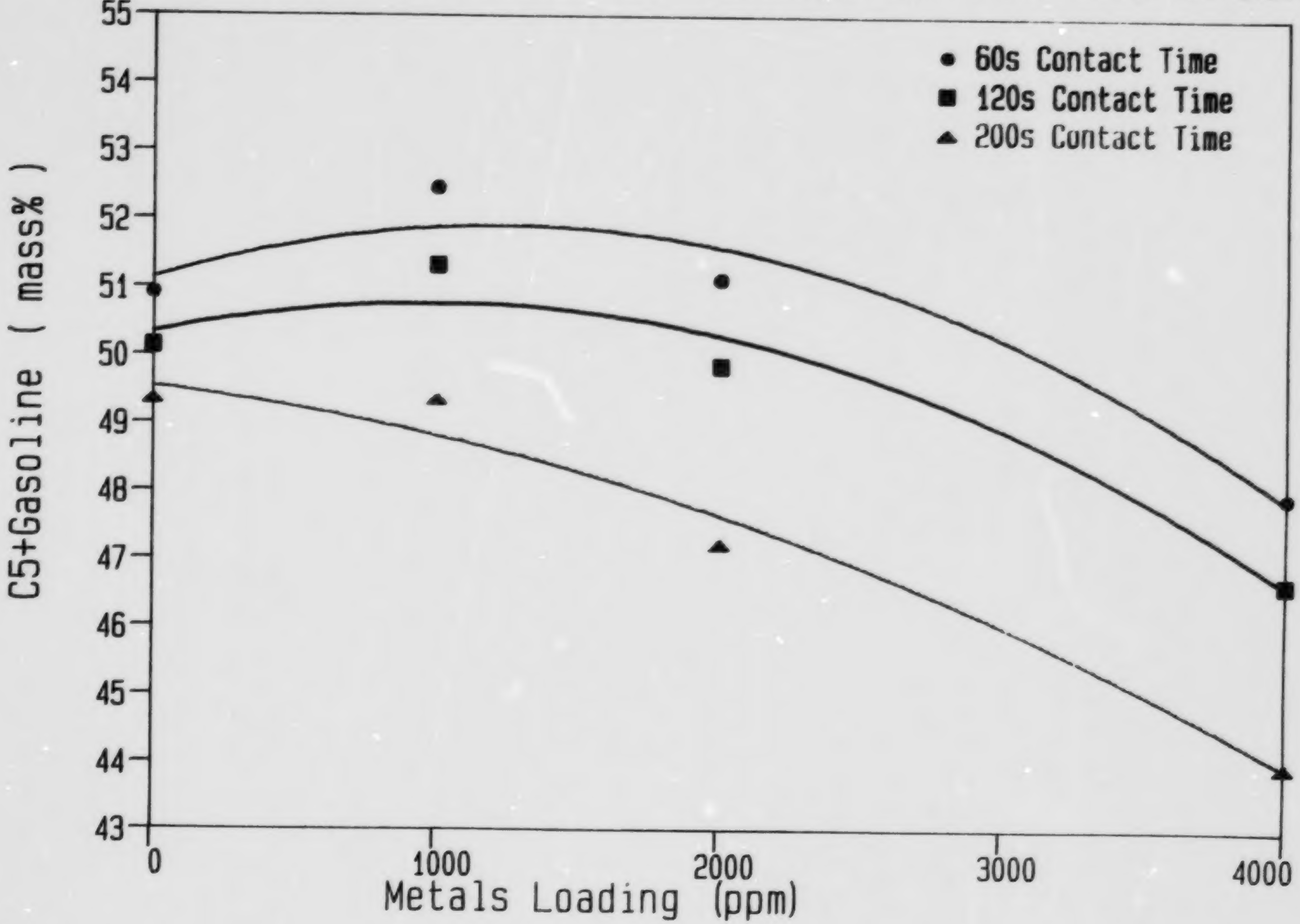
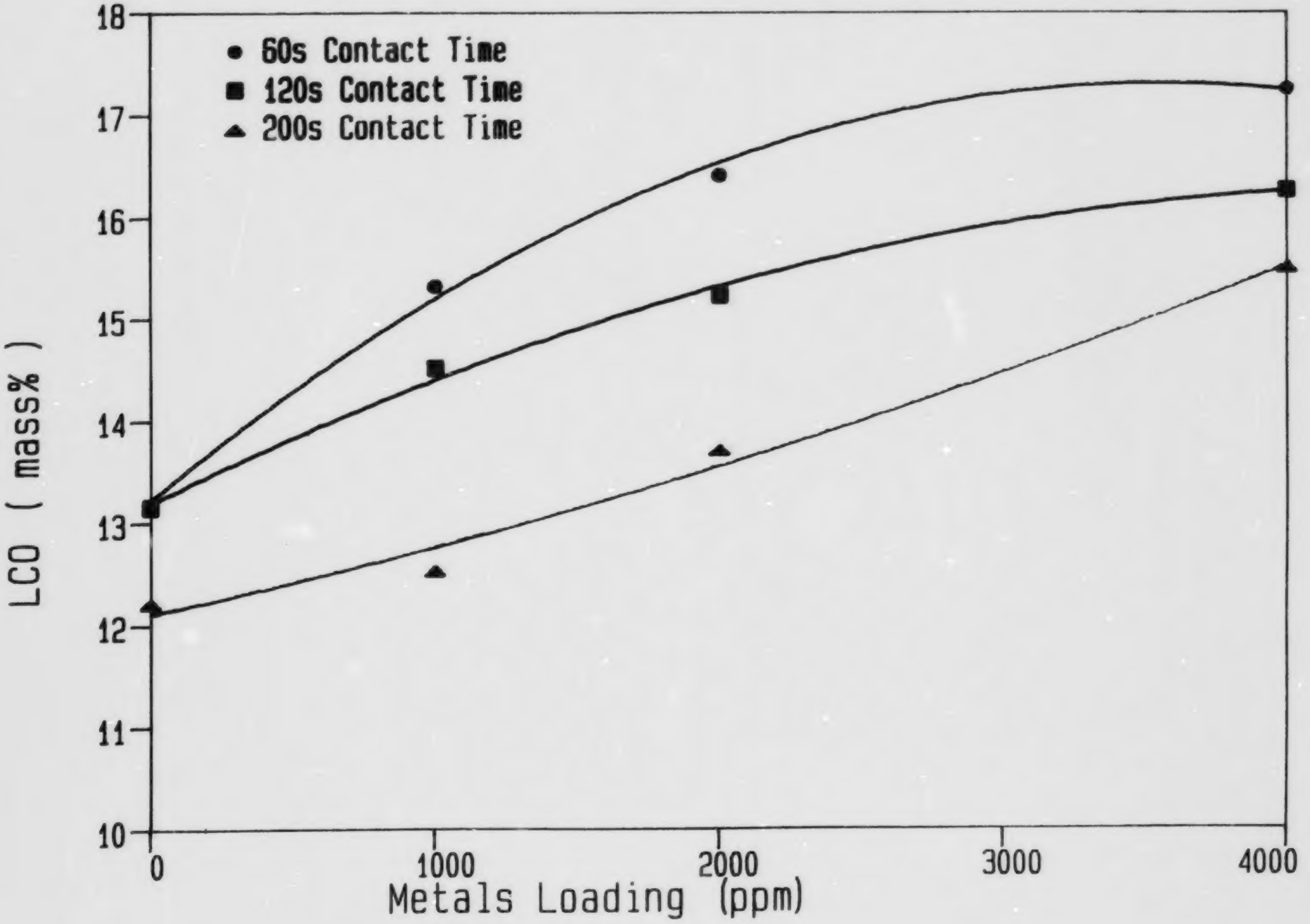


Figure 3.9.6 Effects of Metals on Gas Oil Cracking



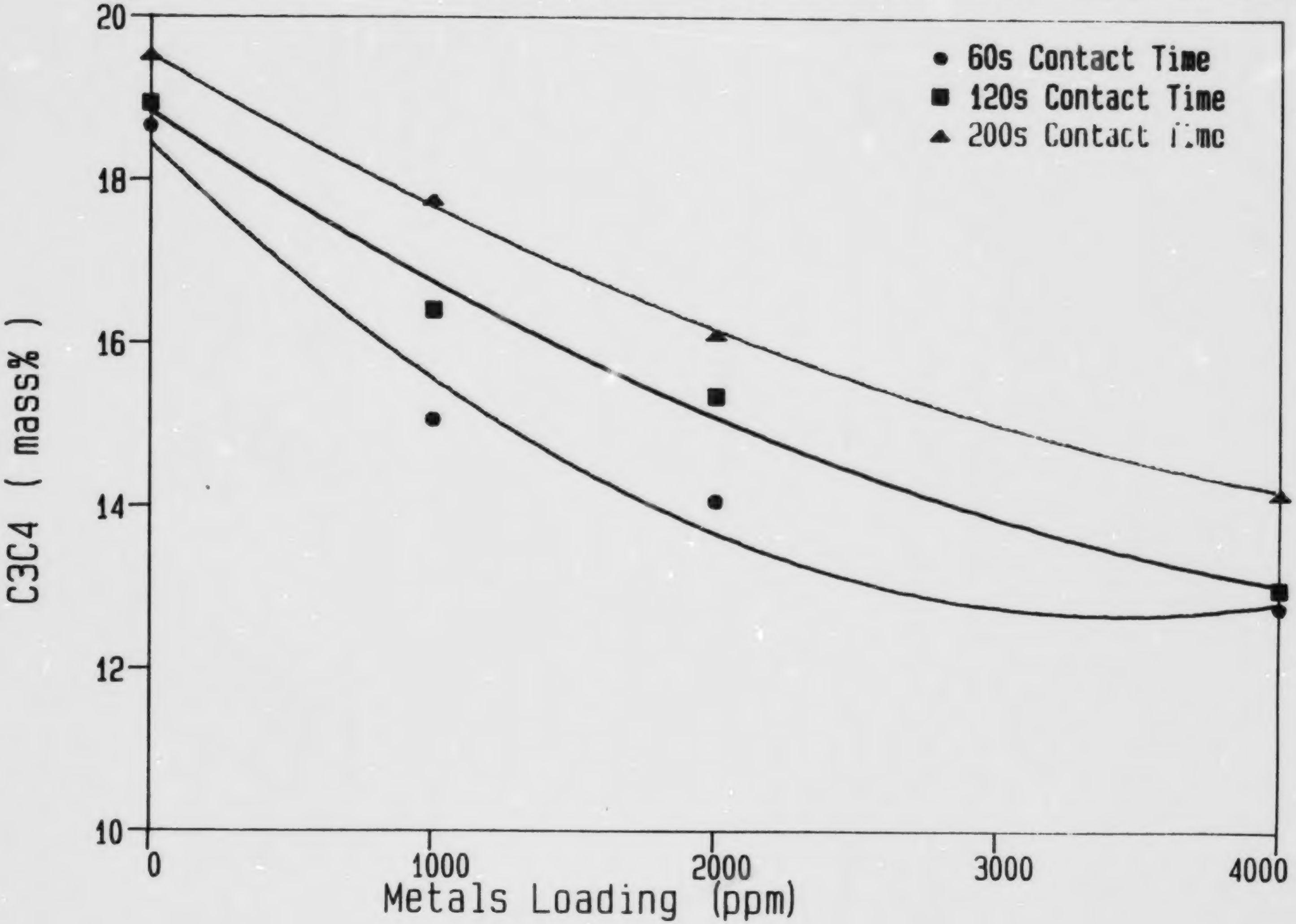
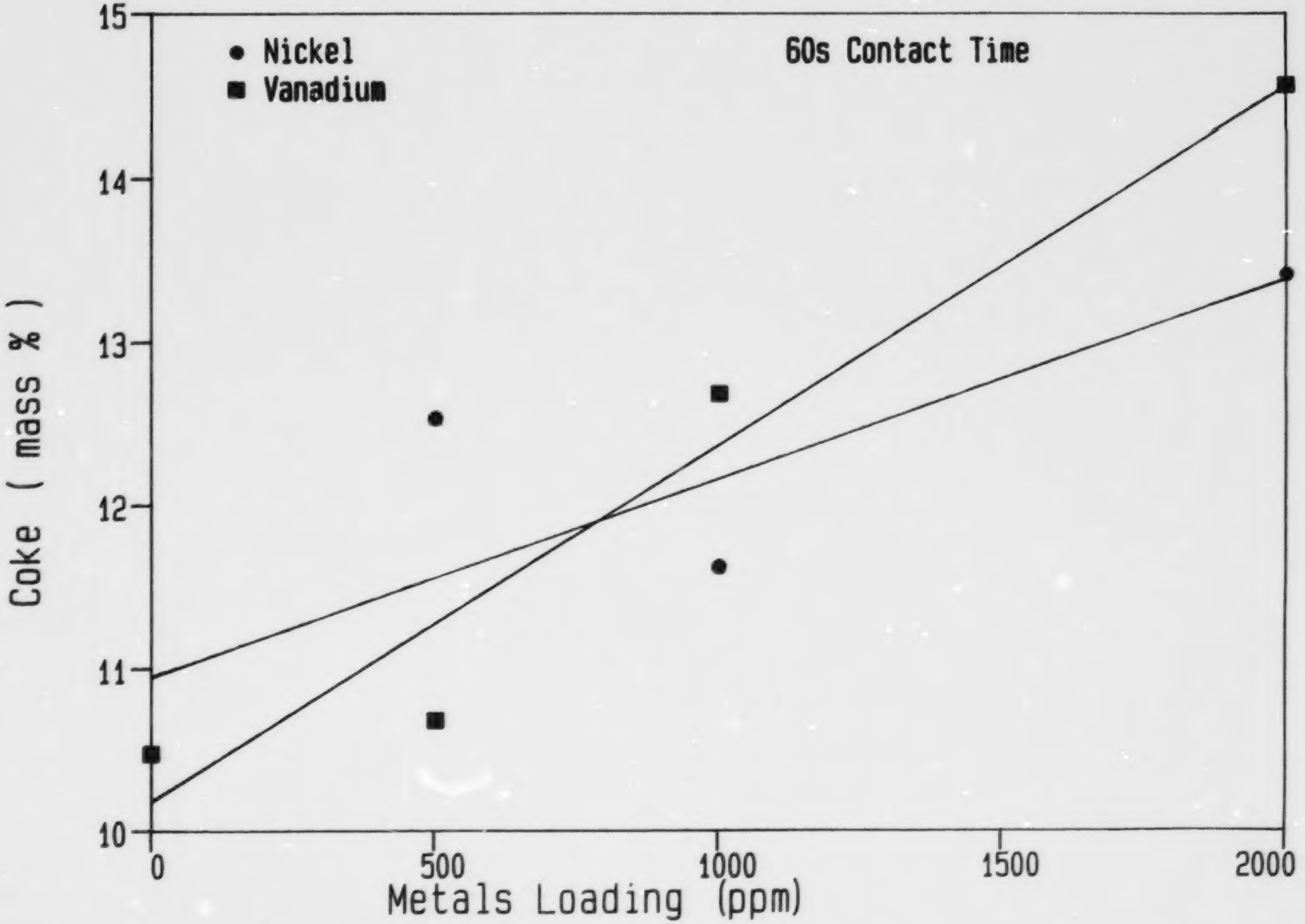


Figure 3.9.7 Effects of Metals on Gas Oil Cracking

Figure 3.9.8 Effects of Metals on Gas Oil Cracking



APPENDIX I

PETRO-CANADA
Research & Development

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
n-Octadecane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	4.2	4.3	4.1	4.6	4.7	4.2	4.2	4.4	4.2
	RMAT016	RMAT014	RMAT015	RMAT006	RMAT005	RMAT004	MP1M690	MP1M689	MP1M692
Compound									
C4 Paraffins	1.84	0.20	0.10	0.00	0.00	0.00	0.14	0.12	0.03
C4 Cyclos+Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.08	0.00
C5 Paraffins	2.42	1.21	1.76	2.95	2.83	1.31	1.64	1.53	0.86
C5 Cyclos+Olefins	2.17	1.74	1.86	1.08	1.22	1.35	0.99	0.81	0.67
C6 Paraffins	5.18	7.92	5.24	7.70	8.86	7.29	4.32	4.80	3.08
C6 Cyclos+Olefins	2.01	2.08	2.32	1.73	1.39	2.14	1.31	1.25	1.14
C6 Alkylbenzenes	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.08	0.06
C7 Paraffins	4.51	5.77	4.54	7.34	8.14	6.89	4.70	4.97	3.30
C7 Cyclos+Olefins	2.67	3.09	2.22	2.66	2.77	2.40	0.89	1.01	0.51
C7 Alkylbenzenes	0.25	0.27	0.50	0.29	0.50	0.61	0.47	1.41	0.67
C8 Paraffins	4.01	4.03	2.82	5.61	5.21	4.89	3.52	4.00	2.19
C8 Cyclos+Olefins	1.59	1.95	1.97	0.43	0.72	0.31	0.66	0.93	0.32
C8 Alkylbenzenes	1.50	1.68	2.87	1.80	3.05	2.84	2.02	2.54	2.38
C9 Paraffins	2.42	2.28	1.71	4.03	2.60	2.57	2.91	2.95	2.06
C9 Cyclos+Olefins	0.75	0.54	0.30	0.00	0.00	0.00	0.14	0.00	0.00
C9 Alkylbenzenes	3.09	3.69	3.28	4.17	4.71	4.45	3.24	3.96	3.27
C10 Paraffins	1.09	1.48	1.11	1.22	0.00	0.00	2.68	1.41	1.11
C10 Cyclos+Olefins	0.42	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10 Alkylbenzenes	1.50	1.88	2.07	3.02	2.49	2.27	2.30	3.03	2.47
C11 Paraffins	0.42	0.40	0.35	0.00	0.00	0.00	2.07	0.24	0.51
C11 Cyclos+Olefins	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00
C11 Alkylbenzenes	1.67	0.94	1.11	1.58	0.72	0.65	1.50	0.97	1.84
C12 Paraffins	0.17	0.34	0.20	0.36	0.28	0.26	1.31	0.52	0.51
C12 Alkylbenzenes	0.92	0.34	0.25	0.00	0.00	0.00	1.74	0.85	0.95
C13 Paraffins	0.00	0.00	0.00	0.22	0.11	0.17	0.89	0.12	0.06
C13 Alkylbenzenes	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.40	0.82
Unreacted Feed	34.93	15.57	9.78	17.85	5.60	1.74	3.66	1.37	2.00
TOTAL:	75.55	57.65	46.36	64.06	51.19	42.14	44.85	39.36	30.80

PETRO-CANADA
Research & Development

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
n-Octadecane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	4.2	4.3	4.1	4.6	4.7	4.2	4.2	4.4	4.2
	RMAT016	RMAT014	RMAT015	RMAT006	RMAT005	RMAT004	MP1M690	MP1M689	MP1M692
PARAFFINS									
C1	0.14	0.26	0.52	0.15	0.32	0.52	0.31	0.58	0.84
C2	0.09	0.18	0.32	0.11	0.19	0.37	0.36	0.52	0.68
C3	1.34	1.85	2.78	1.42	2.20	2.61	2.38	2.80	3.81
C4	9.11	11.86	14.55	10.19	13.59	15.11	16.91	17.99	19.33
C5	6.80	9.47	12.34	10.39	12.22	12.05	13.97	14.42	14.97
C6	6.14	9.21	6.91	9.20	10.97	9.12	6.57	7.00	5.41
C7	4.65	6.01	4.93	7.59	8.14	7.17	5.35	5.60	3.81
C8	4.01	4.03	2.82	5.61	5.21	4.89	3.52	4.00	2.19
C9	2.42	2.28	1.71	4.03	2.60	2.57	2.91	2.95	2.06
C10	1.09	1.48	1.11	1.22	0.00	0.00	2.68	1.41	1.11
C11	0.42	0.40	0.35	0.00	0.00	0.00	2.07	0.24	0.51
C12	0.17	0.34	0.20	0.36	0.28	0.26	1.31	0.52	0.51
C13+	34.93	15.57	9.78	18.07	5.71	1.92	4.56	1.49	2.06
TOTAL	71.31	62.93	58.32	68.34	61.44	56.59	62.90	59.52	57.28
CYCLOS + OLEFINS									
C2	0.06	0.11	0.28	0.05	0.17	0.37	0.17	0.34	0.59
C3	3.82	6.66	8.42	5.19	7.52	9.98	7.88	9.35	11.24
C4	3.20	7.17	8.40	5.53	7.90	9.89	6.74	7.37	9.06
C5	3.23	4.08	4.68	2.91	3.66	4.21	2.49	2.37	2.84
C6	2.22	2.42	2.75	2.05	1.69	2.57	1.69	1.64	1.51
C7	2.67	3.09	2.22	2.66	2.77	2.40	0.89	1.01	0.51
C8	1.59	1.95	1.97	0.43	0.72	0.31	0.66	0.93	0.32
C9	0.75	0.54	0.30	0.00	0.00	0.00	0.14	0.00	0.00
C10	0.42	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00
TOTAL	17.96	26.28	29.02	18.84	24.44	29.73	20.77	23.01	26.07
AROMATICS									
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.14	0.11
C7	0.25	0.27	0.50	0.29	0.50	0.61	0.47	1.41	0.67
C8	1.50	1.68	2.87	1.80	3.05	2.84	2.02	2.54	2.38
C9	3.09	3.69	3.28	4.17	4.71	4.45	3.24	3.96	3.27
C10	1.50	1.88	2.07	3.02	2.49	2.27	2.30	3.03	2.47
C11	1.67	0.94	1.11	1.58	0.72	0.65	1.50	0.97	1.84
C12	0.92	0.34	0.25	0.00	0.00	0.00	1.74	0.85	0.95
C13	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.40	0.82
TOTAL	8.94	8.79	10.08	10.87	11.47	10.82	12.83	13.30	12.51

PETRO-CANADA
Research & Development

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Hexacosane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	3.9	4.2	4.2	4.2	4.8	4.3	4.4	4.0	3.9
	RMAT039	RMAT023	RMAT024	RMAT035	RMAT017	RMAT018	RMAT038	RMAT036	RMAT037
Compounds									
IBC-C11 Paraffins	22.84	26.80	17.04	34.59	32.34	24.46	35.21	27.67	17.40
Cyclos+Olefins	9.25	8.51	4.95	9.58	6.63	3.26	5.18	4.47	2.85
alkylBenzenes	4.77	7.25	5.50	9.05	8.57	8.63	11.41	12.53	11.38
C12-C19 Paraffins	6.94	3.86	6.71	5.32	2.60	3.74	2.44	1.80	0.52
Cyclos+Olefins	1.95	0.86	1.65	0.93	0.11	0.00	0.12	0.15	0.00
alkylBenzenes	2.02	1.93	4.18	4.39	2.32	1.92	3.84	4.72	2.20
C20+ Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclos+Olefins	4.76	1.86	1.87	0.47	1.90	4.59	0.03	0.03	0.01
alkylBenzenes	0.30	0.14	0.33	0.19	0.29	0.63	0.14	0.18	0.10
Unreacted Feed	19.51	15.29	12.65	1.33	0.55	0.77	0.00	0.00	0.00
TOTAL:	72.35	66.49	54.87	65.85	55.31	48.01	58.37	51.55	34.46

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
Hexacosane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	3.9	4.2	4.2	4.2	4.8	4.3	4.4	4.0	3.9
	RMAT039	RMAT023	RMAT024	RMAT035	RMAT017	RMAT018	RMAT038	RMAT036	RMAT037
PARAFFINS									
C1	0.12	0.24	0.35	0.14	0.33	0.22	0.22	0.41	0.75
C2	0.12	0.14	0.28	0.14	0.20	0.19	0.28	0.41	0.65
C3	0.95	1.55	1.70	1.17	2.02	1.84	1.10	1.61	2.52
C4	6.60	8.79	10.08	9.09	12.34	13.89	10.82	12.69	16.02
C5-C11	30.24	34.82	27.59	42.60	41.90	37.77	46.56	39.31	35.30
C12-C19	6.94	3.86	6.71	5.32	2.60	3.74	2.44	1.80	0.52
C20+	19.51	15.29	12.65	1.33	0.55	0.77	0.00	0.00	0.00
TOTAL:	64.47	64.68	59.35	59.80	59.94	58.42	61.44	56.23	55.76
CYCLOS + OLEFINS									
C2	0.08	0.13	0.20	0.05	0.19	0.07	0.20	0.40	0.63
C3	3.80	4.85	7.47	5.21	7.04	7.46	6.22	7.93	10.38
C4	4.14	5.25	8.14	5.70	7.72	8.33	5.94	7.34	9.32
C5-C11	11.96	10.77	9.04	11.95	8.71	6.97	7.41	6.63	7.30
C12-C19	1.95	0.86	1.65	0.93	0.11	0.00	0.12	0.15	0.00
C20+	4.756	1.855	1.869	0.466	1.902	4.590	0.035	0.026	0.007
TOTAL:	26.68	23.72	28.37	24.31	25.66	27.42	19.92	22.47	27.63
AROMATICS									
C6-C11	4.77	7.25	5.50	9.05	8.57	8.63	11.41	12.53	11.38
C12-C19	2.02	1.93	4.18	4.39	2.32	1.92	3.84	4.72	2.20
C20+	0.30	0.14	0.33	0.19	0.29	0.63	0.14	0.18	0.10
TOTAL:	7.10	9.32	10.01	13.63	11.18	11.19	15.39	17.43	13.68

PETRO-CANADA
Research & Development

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Dotriacontane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	4.4	4.5	4.2	3.9	4.7	4.4	4.1	4.0	4.3
	RMAT042	RMAT040	RMAT041	RMAT028	RMAT026	RMAT027	RMAT031	RMAT029	RMAT030
Compounds									
IBC-C11 Paraffins	37.14	27.35	22.02	31.34	29.42	19.78	32.04	31.09	23.80
Cyclos+Olefins	10.37	8.66	8.82	8.08	3.89	1.70	6.08	4.74	2.99
alkylBenzenes	7.08	9.57	9.25	8.08	9.94	12.64	12.75	11.33	10.43
C12-C19 Paraffins	7.92	5.24	5.66	5.47	5.00	4.78	3.10	2.11	1.31
Cyclos+Olefins	1.26	0.80	1.12	0.70	0.22	0.38	0.23	0.00	0.00
alkylBenzenes	3.43	4.10	3.37	3.78	5.88	7.05	4.15	2.01	1.92
C20+ Paraffins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclos+Olefins	1.19	0.66	1.54	0.31	0.28	0.04	0.00	0.22	0.14
alkylBenzenes	0.21	0.49	0.40	0.44	0.83	0.90	0.00	0.04	0.15
Unreacted Feed	1.12	0.40	1.55	0.00	0.07	0.09	0.00	0.00	0.00
TOTAL:	69.72	57.28	53.72	58.19	55.52	47.37	58.35	51.53	40.73

PETRO-CANADA
Research & Development

Task 1. Cracking Yields For Normal Paraffins
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
Dotriacontane on catalyst XC013DE

Contact Time (s)	60			100			200		
Rx. Temperature (C)	450	475	500	450	475	500	450	475	500
Catalyst/oil	4.4	4.5	4.2	3.9	4.7	4.4	4.1	4.0	4.3
	RMAT042	RMAT040	RMAT041	RMAT028	RMAT026	RMAT027	RMAT031	RMAT029	RMAT030
PARAFFINS									
C1	0.13	0.39	0.44	0.22	0.36	0.55	0.19	0.51	0.87
C2	0.18	0.33	0.44	0.07	0.37	0.43	0.27	0.45	0.72
C3	0.88	1.53	1.60	1.04	1.29	1.83	0.52	1.53	2.25
C4	7.54	10.78	10.04	10.48	11.14	12.41	9.27	12.61	14.53
C5-C11	44.11	37.01	32.62	41.90	40.08	31.85	43.47	42.35	37.95
C12-C19	7.92	5.24	5.66	5.47	5.00	4.78	3.10	2.11	1.31
C20+	1.12	0.40	1.55	0.00	0.07	0.09	0.00	0.00	0.00
TOTAL:	61.88	55.69	52.35	59.18	58.29	51.95	56.81	59.56	57.63
CYCLOS + OLEFINS									
C2	0.12	0.32	0.44	0.00	0.00	0.10	0.00	0.09	0.34
C3	4.52	6.80	7.60	6.37	6.96	8.93	6.29	8.33	10.06
C4	5.16	6.70	8.39	7.40	7.45	9.71	5.36	7.83	9.05
C5-C11	12.77	11.42	12.72	11.17	6.62	4.92	9.19	7.19	6.17
C12-C19	1.26	0.80	1.12	0.70	0.22	0.38	0.23	0.00	0.00
C20+	1.191	0.661	1.539	0.308	0.278	0.038	0.000	0.221	0.139
TOTAL:	25.02	26.69	31.81	25.95	21.53	24.08	21.06	23.66	25.76
AROMATICS									
C6-C11	7.08	9.68	9.25	8.08	9.94	12.64	12.92	11.33	10.43
C12-C19	3.43	4.10	3.37	3.78	5.88	7.05	4.15	2.01	1.92
C20+	0.21	0.49	0.40	0.44	0.83	0.90	0.00	0.04	0.15
TOTAL:	10.72	14.27	13.01	12.30	16.65	20.59	17.07	13.37	12.50

PETRO-CANADA
Research & Development

Task 2. Cracking Yields For Other Hydrocarbons
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Cracked on Catalyst [illegible] at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT	1-Octadecene			Tetramethylpentadecane			Triisopropylcyclohexane			Tri-t-Butylbenzene			1-Phenyldodecane		
				Injection Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
				Catalyst/Oil	3.7	4.3	4.0	4.0	3.8	4.1	4.6	4.2	3.8	4.0	4.4	4.2	4.0	4.3	4.2
				File name	RM046	RM045	RM044	M194	M195	M196	M191	M192	M193	M161	M163	M168	M683	M684	M685
1	56	4	0		0.35	0.16	0.44	0.11	0.17	0.10	0.11	0.05	0.05	0.03	0.00	0.07	0.15	0.14	0.13
2	58	4	2	BUTANES	0.00	0.00	0.00	0.06	0.06	0.05	0.00	0.05	0.05	0.00	0.00	0.06	0.23	0.27	0.30
3	70	5	0		2.05	3.61	2.99	1.59	1.50	1.13	0.27	0.32	0.21	0.25	0.12	0.87	0.28	0.21	0.24
4	72	5	2	PENTANES	0.53	0.33	0.44	0.97	1.11	1.04	0.53	0.86	0.79	0.03	0.00	0.04	1.74	1.59	1.55
5	78	6	-6	BENZENE	0.06	0.05	0.17	0.11	0.11	0.10	0.90	1.02	1.11	9.40	9.58	13.41	3.33	4.16	3.43
6	82	6	-2		0.00	0.00	0.00	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		3.76	4.37	4.87	2.61	2.27	1.78	1.12	1.29	1.32	0.16	0.06	0.22	0.61	0.35	0.61
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	2.29	3.82	2.43	2.95	4.43	4.14	2.55	3.11	3.12	0.09	0.03	0.33	3.86	3.60	4.04
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	0.35	0.82	0.94	0.68	0.78	0.89	1.49	1.82	2.16	1.96	2.14	2.69	2.04	2.22	1.88
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.27	0.21	0.00	0.00	0.00	0.00	0.00	0.00
13	98	7	0		4.05	2.29	2.05	1.99	1.83	1.38	3.51	4.02	3.70	0.16	0.00	0.36	1.21	1.18	0.88
14	100	7	2	HEPTANES	6.40	5.57	6.58	6.31	5.76	6.12	2.92	3.22	3.01	0.09	0.09	0.07	4.46	5.47	4.31
15	106	8	-6	XYLENES	4.52	5.30	6.42	1.53	2.77	3.75	4.73	6.22	7.13	1.49	2.70	3.16	3.48	4.29	4.17
16	110	8	-2		0.06	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		1.82	1.69	1.16	0.91	1.11	0.74	2.55	2.84	1.64	0.62	0.59	0.36	0.83	1.11	0.88
18	114	8	2	OCTANES	4.81	5.08	4.48	6.53	5.65	5.82	1.59	1.18	1.69	0.16	0.09	0.36	5.60	5.68	4.85
19	118	9	-8	INDANES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.95	2.77	2.42
20	120	9	-6	C9 AB'S	6.57	5.79	6.80	2.16	4.88	3.50	7.33	8.74	9.35	1.21	1.43	3.78	3.56	4.02	3.97
21	124	9	-2		0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.59	0.49	0.33	0.45	0.33	0.25	1.81	0.80	0.32	0.00	0.03	0.00	0.08	0.00	0.00
23	128	9	2		2.29	1.64	2.05	5.79	4.88	3.31	0.43	0.32	0.16	0.00	0.00	0.00	4.54	3.32	2.96
24	128	10	-12	NAPHTHALENE	0.18	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	5.54	4.98
25	132	10	-8	INDANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.11	5.68	3.12	3.70
26	134	10	-6	C10 AB'S	4.64	4.26	4.53	2.27	3.99	3.01	6.86	8.80	7.18	8.41	6.39	2.04	2.34	1.45	1.88
27	140	10	0		0.53	0.05	0.00	0.11	0.00	0.00	0.69	0.32	0.16	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		0.35	0.22	0.17	3.98	3.16	2.91	0.11	0.11	0.11	0.00	0.00	0.00	1.44	0.69	1.14
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.62	0.91	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	0.29	0.27	0.33	0.11	0.33	0.39	0.27	0.70	1.00	0.00	0.00	0.00	5.14	6.10	5.05
31	146	11	-8		0.00	0.00	0.00	0.00	0.00	0.05	0.43	0.21	0.21	0.06	0.28	0.40	1.06	0.69	0.55
32	148	11	-6		3.29	2.95	2.71	0.85	1.66	1.33	4.46	3.00	2.01	0.31	0.93	0.33	0.45	0.21	0.34
33	154	11	0		0.18	0.00	0.00	0.06	0.06	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.14	0.13
35	156	11	2	C11 PARAFFINS	0.41	0.16	0.00	2.50	1.83	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.28	0.31
36	156	12	-12	DIME NAPHTHALENES	0.82	0.82	0.83	0.74	1.00	1.09	1.17	1.23	1.43	0.31	0.06	0.98	3.40	4.50	4.17
37	160	12	-8		0.35	0.22	0.00	0.00	0.00	0.00	0.16	0.11	0.11	0.00	0.19	0.00	0.00	0.00	0.00
38	162	12	-6		1.70	1.48	0.06	0.62	0.66	0.54	0.48	0.43	0.26	0.09	0.28	0.00	0.23	0.21	0.20
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.11	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.62	0.55
42	170	12	2		0.18	0.16	0.00	2.33	1.05	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.83	0.61
43	170	13	-12	ALKYL NAPHTHALENES	0.82	0.82	0.83	0.68	0.89	1.09	1.17	1.23	1.37	0.34	0.50	0.65	1.14	1.59	1.55
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.19	0.00	0.00	0.00	0.00
45	176	13	-6		0.29	0.22	0.00	0.11	0.11	0.05	0.05	0.05	0.05	0.25	0.15	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.69	0.47
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.48	0.47
51	184	13	2		0.00	0.00	0.00	1.14	0.44	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	184	14	-12		1.23	0.71	0.72	0.68	0.39	0.69	0.80	0.64	0.58	0.12	0.28	0.18	0.68	0.62	0.47
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.56	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.00	0.00	0.00	0.00	0.06	0.05	0.11	0.05	0.11	0.00	0.09	0.04	1.06	0.48	0.55
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.07	0.00
59	198	14	2		0.00	0.00	0.00	0.97	0.17	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.18	0.33	0.00	0.40	0.22	0.20	0.21	0.16	0.21	0.00	0.06	0.00	0.30	0.28	0.13
61	202	16	-22	PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.07	0.20
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.00	0.00	0.00	0.11	0.06	0.10	0.05	0.05	0.11	0.03	0.09	0.04	0.68	0.21	0.47
64	210	15	0		0.00	0.00	0.00	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
66	212	16	-12		0.00	0.00	0.00	0.23	0.11	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.03	0.00	0.53	0.14	0.20
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.00	0.00	0.00	0.06	0.22	0.10	0.00	0.00	0.00	0.06	0.00	0.00	0.38	0.07	0.13
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.13
76	234	17	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
77	234	18	-18		0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
81	242	19	-20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.62	0.00	0.00	0.00	0.00
84	252	18	0	OCTADECENE	0.59	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	56.57	54.14	52.65	52.83	54.25	48.20	51.71	53.69	51.16	28.46	28.64	31.41	73.02	69.27	65.70

Task 2. Cracking Yields For Other Hydrocarbons
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
Cracked on Catalyst XCO13BE at a Reactor Temperature of 477C

		1-Octadecene			Tetramethylpentadecane			Triisopropylcyclohexane			Tri-t-Butylbenzene			1-Phenyldodecane		
	Injection Time (s)	60	120	200	60	120	200	60	120	200	60	120	200	60	120	200
	Catalyst/Oil	3.7	4.3	4.0	4.0	3.8	4.1	4.6	4.2	3.8	4.0	4.4	4.2	4.0	4.3	4.2
	File name	RM046	RM045	RM044	M194	M195	M196	M191	M192	M193	M161	M163	M160	M683	M684	M685
PARAFFINS																
	C1	0.40	0.48	0.55	0.29	0.39	0.47	0.23	0.28	0.32	0.30	0.33	0.44	0.16	0.23	0.29
	C2	0.40	0.47	0.54	0.28	0.33	0.37	0.22	0.29	0.34	0.00	0.00	0.00	0.24	0.35	0.41
	C3	0.99	1.32	1.34	0.71	1.00	1.38	2.14	3.22	3.66	0.00	0.00	0.00	1.91	2.59	2.97
	C4	9.07	10.43	10.77	13.78	13.50	15.41	22.36	22.42	23.41	15.02	17.06	23.30	9.03	10.22	11.84
	C5	8.34	8.74	8.97	10.09	9.85	11.63	9.90	9.68	10.14	1.30	1.61	3.21	7.59	7.88	8.80
	C6	3.58	5.24	3.83	4.30	5.68	6.00	3.87	4.39	4.63	0.62	0.53	0.81	4.60	4.36	4.87
	C7	7.01	6.01	7.10	6.73	6.25	6.67	3.29	3.59	3.48	0.09	0.09	0.44	4.75	5.77	4.58
	C8	4.81	5.08	4.48	6.53	5.65	5.82	1.59	1.18	1.69	0.16	0.09	0.36	5.60	5.68	4.85
	C9	2.29	1.64	2.05	5.79	4.88	3.31	0.43	0.32	0.16	0.00	0.00	0.00	4.54	3.32	2.96
	C10	0.35	0.22	0.17	3.98	3.16	2.91	0.11	0.11	0.11	0.00	0.00	0.00	1.44	0.69	1.14
	C11	0.41	0.16	0.00	2.50	1.83	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.28	0.81
	C12	0.18	0.16	0.00	2.33	1.05	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.83	0.61
	C13+	0.00	0.00	0.00	2.10	0.61	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
	TOTAL	37.83	39.96	39.79	59.43	54.18	56.27	44.14	45.48	47.94	17.49	19.72	28.56	40.98	42.20	44.26
OLEFINS																
	C2	0.33	0.41	0.48	0.20	0.27	0.38	0.44	0.60	0.73	0.00	0.00	0.00	0.20	0.32	0.34
	C3	7.56	7.85	8.52	7.65	7.47	7.98	6.34	4.62	4.65	2.01	2.51	4.05	3.49	3.75	3.85
	C4	8.39	7.96	8.19	7.98	7.10	7.11	2.67	1.60	1.49	42.73	37.98	29.33	2.30	2.06	2.10
	C5	4.81	5.90	4.92	3.75	3.13	2.82	0.64	0.48	0.34	1.72	1.71	2.24	0.58	0.39	0.53
	C6	4.40	4.85	5.32	3.19	2.64	2.15	1.37	1.53	1.63	1.37	0.99	0.67	0.61	0.35	0.61
	C7	4.05	2.29	2.05	1.99	1.83	1.38	3.80	4.35	4.09	0.16	0.29	0.36	1.21	1.18	0.88
	C8	1.82	1.69	1.16	0.91	1.11	0.74	2.55	2.84	1.64	0.62	0.59	0.36	0.83	1.11	0.88
	C9	0.59	0.49	0.33	0.45	0.33	0.25	1.81	0.80	0.32	0.00	0.03	0.00	0.08	0.00	0.00
	C10	0.53	0.05	0.00	0.11	0.00	0.00	0.69	0.32	0.16	0.00	0.00	0.00	0.00	0.00	0.00
	C11	0.18	0.00	0.00	0.06	0.06	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.11	0.00	0.00	0.00	0.00	0.00	0.00
	C13+	0.59	0.33	0.17	0.00	0.00	0.00	2.39	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	33.24	31.83	31.14	26.29	23.94	22.81	22.80	17.48	15.20	48.61	44.10	37.02	9.30	9.16	9.19
cycloOLEFINS																
	C5	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C6	0.00	0.00	0.00	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C7	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.27	0.21	0.00	0.00	0.00	0.00	0.00	0.00
	C8	0.06	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C9	0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	0.14	0.00	0.06	0.11	0.11	0.05	0.33	0.27	0.21	0.00	0.00	0.00	0.00	0.00	0.00
AROMATICS																
	C6	0.06	0.05	0.17	0.16	0.14	0.10	1.02	1.15	1.27	10.80	11.72	14.02	3.44	4.30	3.58
	C7	0.35	0.82	0.94	0.75	0.84	0.89	1.49	1.88	2.24	1.96	2.21	2.69	2.04	2.22	1.88
	C8	4.58	5.30	6.42	1.60	2.87	3.75	4.73	6.22	7.13	1.49	2.70	3.16	3.54	4.35	4.17
	C9	6.63	5.79	6.86	2.16	4.88	3.50	7.33	8.74	9.35	1.21	1.43	3.78	6.51	6.79	6.39
	C10	4.81	4.37	4.65	2.27	3.99	3.01	6.86	8.80	7.18	8.56	7.10	3.05	13.32	10.11	10.56
	C11	3.58	3.22	3.04	0.97	1.99	1.78	5.16	3.92	3.22	0.37	1.21	0.73	6.65	7.00	5.94
	C12	2.88	2.51	0.88	1.36	1.66	1.63	1.81	1.77	1.80	0.40	0.53	0.98	3.78	4.85	4.50
	C13+	2.52	2.08	1.55	2.27	2.16	2.42	2.44	2.31	2.53	3.46	2.94	0.91	7.65	5.33	5.39
	TOTAL	25.41	24.15	24.50	11.54	18.54	17.07	30.84	34.78	34.72	28.27	29.83	29.32	46.93	44.95	42.41

X

P E T R O - C A N A D A
Research & Development

Task I. Cracking Yields For Major Sulfur and Nitrogen Species
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Analysis
KC0132E Catalyst at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT	Octadecylthiol			Undecyl Sulfide			Octyl Sulfide		
				Contact Time (s)	60	120	200	60	120	200	60	120	200
				Catalyst/oil	3.8	3.8	3.8	3.6	3.8	3.8	3.6	3.8	3.8
					M698	M694	M696	M156	M198	M158	R054	R053	R052
1	56	4	0		0.05	0.05	0.05	0.05	0.05	0.05	0.13	0.14	0.13
2	58	4	2	BUTANES	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
3	70	5	0		0.81	0.87	0.82	0.20	0.21	0.19	1.04	1.13	0.80
4	72	5	2	PENTANES	0.66	0.49	0.47	0.49	0.37	0.24	0.17	0.14	0.12
5	78	6	-6	BENZENE	0.15	0.11	0.15	0.15	0.11	0.15	0.04	0.05	0.04
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		1.67	1.55	1.39	1.08	1.00	0.88	1.25	1.22	1.18
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.64	0.58	0.63	0.27	0.26	0.27
9	86	6	2	HEXANES	3.44	2.99	2.91	2.06	1.79	1.70	1.75	1.36	1.48
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.24	0.21	0.05	0.10	0.09	0.02
11	92	7	-6	TOLUENE	1.11	0.94	1.31	2.10	1.79	2.43	0.46	0.50	0.89
12	96	7	-2		0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00
13	98	7	0		1.37	1.07	1.45	2.01	1.58	2.09	0.92	1.45	1.35
14	100	7	2	HEPTANES	4.81	5.52	3.92	2.74	3.17	2.19	1.04	0.72	0.72
15	106	8	-6	XYLENES	3.29	3.12	3.84	5.48	5.22	6.28	5.47	5.20	5.08
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		1.16	1.20	0.91	1.27	1.32	0.97	1.17	4.07	2.11
18	114	8	2	OCTANES	4.35	3.91	3.13	1.52	1.37	1.07	19.80	24.38	25.25
19	118	9	-8	INDANES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	120	9	-6	C9 AB'S	4.35	4.46	4.89	5.48	5.65	6.04	2.97	2.80	2.11
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.00	0.00	0.15	0.16	0.10	0.04	0.05	0.08
23	128	9	2		3.84	3.53	5.02	0.34	0.32	0.44	0.00	0.00	0.00
24	128	10	-12	NAPHTHALENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	132	10	-8	INDANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	134	10	-6	C10 AB'S	2.83	3.71	3.57	2.64	3.48	3.26	2.21	1.00	0.25
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		2.28	1.75	1.45	0.10	0.00	0.00	0.00	0.00	0.00
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	0.61	0.70	0.73	2.40	2.80	2.82	0.29	0.05	0.04
31	146	11	-8		0.00	0.00	0.00	1.22	0.84	0.54	0.00	0.00	0.00
32	148	11	-6		1.67	2.62	1.45	3.72	5.86	3.17	1.00	0.32	0.13
	154	11	0		0.00	0.00	0.00	0.73	0.37	0.34	0.00	0.00	0.00
34	154	12	-14		0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00
35	156	11	2	C11 PARAFFINS	2.33	2.23	1.54	3.23	3.11	2.09	0.00	0.00	0.00
36	156	12	-12	DIME NAPHTHALENES	1.32	1.83	1.88	2.15	3.01	3.02	0.58	0.23	0.13
37	160	12	-8		0.00	0.00	0.00	0.10	0.05	0.00	0.00	0.00	0.00
38	162	12	-6		0.61	0.22	0.48	0.44	0.16	0.34	0.58	0.09	0.04
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	170	12	2		1.42	1.29	1.22	0.00	0.00	0.00	0.00	0.00	0.00
43	170	13	-12	ALKYL NAPHTHALENES	1.11	2.02	1.44	1.42	2.59	1.80	0.25	0.09	0.08
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.24	0.37	0.10	0.04	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.05	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
51	184	13	2		0.91	0.92	1.00	0.00	0.00	0.00	0.00	0.00	0.00
52	184	14	-12		0.51	0.69	0.38	0.73	1.00	0.54	0.13	0.05	0.04
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.15	0.21	0.10	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.15	0.16	0.12	0.24	0.26	0.19	0.00	0.00	0.00
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.00	0.00	0.00	0.15	0.16	0.00	0.00	0.00	0.00
59	198	14	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.25	0.22	0.10	0.24	0.21	0.10	0.00	0.00	0.00
61	202	16	-22	PYRENE	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.10	0.11	0.10	0.20	0.21	0.19	0.00	0.00	0.00
64	210	15	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	212	15	2		0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.00	0.00	0.00	0.10	0.05	0.05	0.00	0.00	0.00
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.00	0.00	0.00	0.15	0.16	0.05	0.00	0.00	0.00
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.20	0.22	0.24	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.00	0.00	0.00	0.05	0.05	0.05	0.00	0.00	0.00
76	234	17	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
77	234	18	-18		0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
78	240	17	2		0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	1.06	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	260	19	2	TWPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	48.77	49.25	46.31	46.59	50.13	44.36	41.72	45.36	42.37

Task 3. Cracking Yields For Major Sulfur and Nitrogen Species
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
XC013DE Catalyst at a Reactor Temperature of 477C

		Octadecalthiol			Undecyl Sulfide			Octyl Sulfid C8SC8		
Contact Time (s)		60	120	200	60	120	200	60	120	200
Catalyst/oil		3.8	3.8	3.8	3.6	3.8	3.8	3.6	3.9	3.8
		M688	M694	M696	M156	M198	M158	R054	R053	R052
PARAFFINS										
	C1	0.49	0.52	0.57	0.95	0.92	1.06	0.52	0.45	0.52
	C2	0.63	0.60	0.62	1.14	1.08	1.24	1.18	1.54	1.23
	C3	1.38	1.64	1.76	2.30	2.22	2.90	1.53	1.39	1.65
	C4	9.95	9.83	10.21	10.96	9.95	11.62	8.71	7.82	9.33
	C5	10.20	9.29	9.19	9.20	9.17	10.15	7.12	6.53	7.47
	C6	5.45	4.71	4.41	3.93	3.96	4.06	2.16	1.81	2.10
	C7	5.41	6.09	4.46	3.39	3.74	2.95	1.75	1.39	1.30
	C8	4.35	3.91	3.13	1.52	1.37	1.07	19.80	24.38	25.25
	C9	3.84	3.53	5.02	0.34	0.32	0.44	0.00	0.00	0.00
	C10	2.28	1.75	1.45	0.10	0.00	0.00	0.00	0.00	0.00
	C11	2.33	2.23	1.54	3.23	3.11	2.09	0.00	0.00	0.00
	C12	1.42	1.29	1.22	0.00	0.00	0.00	0.00	0.00	0.00
	C13+	2.38	1.73	1.45	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	50.10	47.13	45.02	37.05	35.85	37.58	42.77	45.31	48.85
OLEFINS										
	C2	0.28	0.28	0.34	1.05	0.94	1.08	0.49	0.00	0.52
	C3	7.22	6.90	7.48	8.22	6.91	7.42	8.22	7.71	8.12
	C4	6.81	6.99	8.90	4.91	3.90	3.87	10.02	9.86	9.49
	C5	2.92	2.59	2.41	1.00	1.02	0.95	3.69	3.94	3.10
	C6	2.11	1.89	1.69	1.55	1.48	1.53	1.76	1.71	1.61
	C7	1.37	1.07	1.45	2.35	1.92	2.41	0.92	1.45	1.35
	C8	1.16	1.20	0.91	1.27	1.32	0.97	1.17	4.07	2.11
	C9	0.00	0.00	0.00	0.15	0.16	0.10	0.04	0.05	0.08
	C10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C11	0.00	0.00	0.00	0.73	0.37	0.34	0.00	0.00	0.00
	C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C13+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	21.86	20.92	23.20	21.23	18.03	18.67	26.31	28.78	26.39
cycloOLEFINS										
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C7	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00
	C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00
AROMATICS										
	C6	0.23	0.18	0.22	0.21	0.16	0.23	0.21	0.23	0.23
	C7	1.11	0.94	1.31	2.18	1.88	2.54	0.46	0.50	0.89
	C8	3.36	3.19	3.91	5.48	5.36	6.28	5.47	5.20	5.08
	C9	4.35	4.46	4.89	5.48	5.65	6.04	2.97	2.80	2.11
	C10	2.83	3.71	3.57	2.64	3.48	3.26	2.21	1.00	0.25
	C11	2.28	3.32	2.18	7.34	9.50	6.52	1.29	0.36	0.17
	C12	2.02	2.15	2.46	2.69	3.22	3.36	1.17	0.32	0.17
	C13+	2.18	3.24	2.17	3.82	5.44	3.17	0.42	0.14	0.13
	TOTAL	18.36	21.19	20.72	29.85	34.68	31.40	14.20	10.54	9.03

P E T R O - C A N A D A
Research & Development

Task 3.A. Effects of Nitrogen Poisoning on Cracking Yields
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
*CuSIZE catalyst at Reactor Temperature 477C and 6us Contact Time

ENTRY	MASS	C #	Z #	COMPONENT	Blend A					BLEND B					BLEND C				
				Nitrogen (ppm)	0	400	800	1600	2200	0	400	800	1600	2200	0	400	800	1600	2200
				Catalyst/oil	4.2	4.2	3.6	4.0	4.1	4.2	3.900	4.2	3.9	3.9	4.2	4.2	4.1	[illegible]	[illegible]
					M326	M501	M504	M508	M512	M687	M507	M615	M510	M616	M686	M500	M502	M515	M517
1	56	4	0		0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00
2	56	4	2	BUTANES	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00
3	70	5	0		0.18	1.31	1.18	1.08	0.36	0.17	0.60	1.07	0.08	1.00	0.25	0.66	0.81	0.76	1.18
4	72	5	2	PENTANES	0.06	0.81	0.82	0.86	0.22	0.74	0.60	1.27	0.39	1.41	0.87	1.31	1.21	1.16	1.13
5	78	6	-6	BENZENE	0.80	0.56	0.41	0.43	0.50	0.74	0.87	0.94	1.18	0.91	1.25	0.79	1.41	1.36	1.15
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00
7	84	6	0		0.86	2.49	3.00	3.08	2.81	1.03	1.27	1.87	1.18	1.41	1.00	1.57	2.01	2.32	2.66
8	84	4	-4	S THIOPHENE	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	1.17	3.61	3.00	3.23	2.30	2.86	2.75	3.48	3.69	3.99	3.25	4.85	4.63	4.33	1.59
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	0.98	0.81	0.65	1.00	0.72	0.91	0.87	0.80	0.63	0.75	1.56	0.46	0.67	0.76	1.24
12	96	7	-2		0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.13	0.32	0.00
13	98	7	0		1.23	1.37	1.83	1.86	2.52	1.77	2.14	2.07	2.51	2.08	2.19	2.88	3.09	4.33	3.81
14	100	7	2	HEPTANES	2.65	4.54	3.77	4.59	3.53	4.12	4.02	4.15	3.69	4.07	4.56	5.11	6.78	6.01	3.19
15	106	8	-6	XYLENES	3.20	2.43	2.30	2.65	3.10	2.92	2.75	2.41	2.36	2.00	4.18	1.70	1.48	3.68	2.75
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		0.98	1.80	2.18	3.01	4.25	1.77	1.94	2.01	2.12	2.08	2.12	4.85	2.28	3.12	2.92
18	114	8	2	OCTANES	4.80	8.77	8.72	10.61	8.07	4.46	4.42	3.88	4.79	2.99	5.68	4.65	6.11	6.49	4.08
19	118	9	-8	INDANES	0.74	0.50	0.59	0.72	0.65	0.91	1.01	1.14	0.63	0.08	1.50	1.44	0.67	0.96	1.42
20	120	9	-6	C9 AB'S	2.77	2.30	2.18	2.65	2.81	3.32	3.02	3.08	3.53	2.66	4.43	2.03	2.48	2.40	2.57
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.50	0.41	0.79	1.15	0.23	0.47	0.87	0.63	0.33	0.44	0.26	0.60	0.96	0.62
23	128	9	2		2.03	3.11	3.00	3.87	3.24	3.03	3.89	2.81	3.22	1.41	3.68	3.41	3.09	3.77	3.28
24	128	10	-12	NAPHTHALENE	3.63	2.30	2.00	2.37	2.30	2.23	3.28	2.34	3.22	1.50	3.50	3.28	3.15	2.72	4.34
25	132	10	-8	INDANE	0.31	0.00	0.12	0.00	0.14	0.86	0.74	0.87	0.47	0.58	1.87	2.03	1.21	2.56	1.77
26	134	10	-6	C10 AB'S	1.60	1.12	1.18	1.22	1.58	2.29	1.61	2.61	2.75	1.66	2.81	1.64	2.01	1.28	2.30
27	140	10	0		0.00	0.68	0.88	1.51	1.01	0.11	0.00	0.40	0.00	0.50	0.00	0.20	0.27	0.56	0.62
28	142	10	2		2.15	1.93	2.00	2.58	2.23	1.66	3.89	2.07	2.59	1.33	1.62	1.44	2.15	2.24	1.24
29	142	10	-12		0.00	3.36	3.12	2.87	3.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	4.18	0.00	0.00	0.00	0.00	3.20	4.22	3.34	3.45	1.66	3.81	3.73	3.15	1.92	4.96
31	146	11	-8		0.12	0.00	0.00	0.00	0.00	0.40	0.80	0.53	0.31	0.33	0.50	1.05	0.40	0.48	2.30
32	148	11	-6		0.37	0.75	0.53	0.93	0.94	0.86	2.08	1.14	2.04	0.67	0.81	0.52	0.94	0.80	0.18
33	154	11	0		0.00	0.75	0.41	0.72	1.01	0.00	0.00	0.13	0.24	0.42	0.00	0.13	0.20	0.32	0.09
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
35	156	11	2	C11 PARAFFINS	1.54	1.87	2.00	2.72	2.09	2.17	3.28	1.34	2.67	0.42	0.56	1.18	1.14	1.28	1.24
36	156	12	-12	DIME NAPHTHALENES	2.95	2.24	1.65	1.65	1.66	2.00	1.34	1.94	2.59	1.58	2.56	2.29	1.34	0.88	3.37
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.00	0.31	0.24	0.36	0.65	0.46	0.00	0.27	0.39	0.00	0.25	0.13	0.20	0.16	0.44
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.56	0.65	0.72	0.29	0.00	0.00	0.07	0.00	0.33	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIARON.	0.86	0.56	0.77	0.36	0.36	0.46	1.14	0.27	0.63	0.08	0.44	0.92	0.67	0.72	1.33
42	170	12	2		2.15	1.00	1.35	1.51	1.66	0.23	2.41	0.67	1.18	0.33	0.25	0.46	0.81	0.96	0.71
43	170	13	-12	ALKYL NAPHTHALENES	1.54	1.00	1.18	1.00	0.86	1.32	1.34	1.20	1.33	1.16	0.75	1.57	0.87	1.12	1.33
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	1.85	0.50	0.29	0.22	0.14	0.74	0.34	0.33	0.31	0.25	0.56	0.72	0.34	0.24	0.18
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.80	0.44	0.06	0.14	0.36	0.46	0.40	0.60	0.63	0.42	0.31	0.52	0.27	0.76	0.50
51	184	13	2		0.00	0.68	0.65	0.57	0.86	0.40	0.34	0.27	0.39	0.00	0.00	0.13	0.13	0.32	0.27
52	184	14	-12		0.80	0.87	1.18	0.22	0.65	0.46	0.40	0.60	0.63	0.42	0.37	0.79	0.40	0.56	0.71
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	1.91	0.50	0.18	0.22	0.29	0.51	0.20	0.07	0.16	0.00	0.56	0.52	0.34	0.32	0.25
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.12	0.25	0.06	0.36	0.07	0.17	0.13	0.07	0.31	0.17	0.12	0.13	0.07	0.16	0.09
59	198	14	2		0.00	0.31	0.06	0.22	0.22	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.18	0.19	0.00	0.00	0.00	0.23	0.47	0.07	0.00	0.00	0.19	0.26	0.13	0.08	0.00
61	202	16	-22	PYRENE	0.31	0.06	0.06	0.00	0.00	0.11	0.07	0.00	0.00	0.00	0.19	0.26	0.00	0.00	0.09
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	1.78	0.25	0.12	0.07	0.14	0.57	0.20	0.13	0.24	0.17	0.37	0.66	0.13	0.08	0.18
64	210	15	0		0.00	0.00	0.00	0.00	0.00	3.32	3.08	4.35	6.83	14.30	1.56	1.57	2.08	4.01	8.95
65	212	15	2		0.00	0.00	0.12	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.62	0.06	0.18	0.07	0.07	0.17	0.13	0.07	0.16	0.08	0.12	0.52	0.13	0.08	0.16
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.68	0.19	0.06	0.07	0.00	0.29	0.13	0.07	0.08	0.08	0.31	0.39	0.07	0.08	0.18
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.37	0.00	0.29	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.62	0.00	0.06	0.00	0.00	0.06	0.07	0.00	0.00	0.00	0.00	0.26	0.13	0.08	0.09
76	234	17	-18		0.12	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.31	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.18	0.22	0.36	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.13	0.40	0.44
80	242	19	-24		0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.55	0.75	2.18	3.44	4.39	0.40	1.07	2.67	5.18	10.73	0.00	0.39	0.47	5.21	10.90
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	1.05	0.44	0.82	1.08	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.27	0.48	0.35
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.87	3.14	5.73	13.89	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	56.61	58.81	58.96	68.16	65.83	55.52	64.80	64.26	75.14	80.25	61.43	64.07	61.07	74.42	81.59

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Task 3.A. Effects of Nitrogen Poisoning on Cracking Yields
Reactor Effluent Carbon Distribution
by
Hydrocarbon Types
XC0130E catalyst at Reactor Temperature 477C and 60s Contact Time

	Blend A					BLEND B					BLEND C				
Nitrogen (ppm)	0	400	800	1600	3200	0	400	800	1600	3200	0	400	800	1600	3200
Catalyst/oil	4.2	4.2	3.6	4.0	4.1	4.2	3.800	4.2	3.9	3.9	4.2				
	M326	M501	M504	M508	M513	M687	M507	M615	M510	M616	M686	M500	M502	M505	M503
PARAFFINS															
C1	0.29	0.33	0.26	0.21	0.39	0.21	0.12	0.14	0.09	0.10	0.19	0.19	0.15	0.10	0.09
C2	0.43	0.60	0.51	0.41	0.73	0.29	0.20	0.24	0.13	0.16	0.28	0.29	0.24	0.19	0.14
C3	1.37	1.51	1.22	0.88	1.57	1.46	0.85	1.00	0.52	0.58	1.45	1.34	1.05	0.77	0.50
C4	9.95	8.98	8.17	5.84	6.53	14.77	11.43	12.39	6.89	6.49	12.86	11.72	10.83	7.68	4.28
C5	9.01	9.15	8.45	6.87	5.80	11.52	9.43	9.31	6.71	5.43	10.34	9.97	11.52	7.31	4.15
C6	2.71	5.03	4.47	4.19	3.29	4.67	4.27	4.75	4.95	4.58	4.72	6.27	6.74	5.22	2.35
C7	3.39	4.98	4.50	5.11	4.04	4.79	4.59	4.66	4.46	4.34	5.02	5.75	7.67	6.45	3.71
C8	4.80	8.77	8.72	10.61	8.07	4.46	4.42	3.88	4.79	2.99	5.69	4.65	6.11	6.49	4.08
C9	2.03	3.11	3.00	3.87	3.24	3.03	3.89	2.81	3.22	1.41	3.68	3.41	3.09	3.77	3.28
C10	2.15	1.93	2.00	2.58	2.23	1.66	3.89	2.07	2.59	1.33	1.62	1.44	2.15	2.24	1.24
C11	1.54	1.87	2.00	2.72	2.09	2.17	3.28	1.34	2.67	0.42	0.56	1.18	1.14	1.28	1.24
C12	2.15	1.00	1.35	1.51	1.66	0.23	2.41	0.67	1.18	0.33	0.25	0.46	0.81	0.96	0.71
C13+	1.72	1.43	2.12	2.22	3.03	0.40	1.34	3.41	6.12	13.89	0.00	0.20	0.40	0.80	0.62
TOTAL	41.56	48.70	46.79	47.02	42.66	49.65	50.13	46.66	44.31	42.05	46.66	46.85	51.89	43.26	26.38
OLEFINS															
C2	0.22	0.34	0.25	0.20	0.38	0.14	0.08	0.18	0.01	0.11	0.19	0.16	0.09	0.10	0.06
C3	6.23	6.22	6.31	4.92	4.84	5.54	4.66	5.10	3.23	3.28	4.77	4.66	4.95	3.74	2.59
C4	5.72	5.83	6.53	5.13	5.08	4.29	3.78	3.69	2.66	2.35	3.44	3.46	3.79	3.28	2.51
C5	1.57	2.89	3.36	3.03	2.40	1.03	1.48	1.98	0.96	1.54	0.70	1.21	1.46	1.86	1.26
C6	1.23	2.83	3.59	3.58	3.39	1.32	1.55	2.53	1.58	1.64	1.17	1.82	2.34	2.63	3.12
C7	1.23	1.37	1.83	1.86	2.52	1.77	2.14	2.07	2.82	2.08	2.19	2.88	3.46	4.33	4.08
C8	0.98	1.80	2.18	3.01	4.25	1.77	1.94	2.01	2.12	2.08	2.12	4.85	2.28	3.12	2.92
C9	0.00	0.50	0.41	0.79	1.15	0.23	0.47	0.87	0.63	0.33	0.44	0.26	0.60	0.96	0.62
C10	0.00	0.68	0.88	1.51	1.01	0.11	0.00	0.40	0.00	0.50	0.00	0.20	0.27	0.56	0.62
C11	0.00	0.75	0.41	0.72	1.01	0.00	0.00	0.13	0.24	0.42	0.00	0.13	0.20	0.32	0.09
C12	0.00	0.56	0.65	0.72	0.29	0.00	0.00	0.07	0.00	0.33	0.00	0.00	0.00	0.00	0.00
C13+	0.00	0.00	0.00	0.00	0.00	3.32	3.08	4.35	6.83	14.30	1.56	1.57	2.08	4.01	8.95
TOTAL	17.19	23.77	26.40	25.46	26.31	19.52	19.20	23.38	21.08	28.96	16.58	21.20	21.53	24.91	26.83
cycloOLEFINS															
C5	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.13	0.32	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.06	0.00	0.00	0.02	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.13	0.32	0.00
AROMATICS															
C6	0.88	0.60	0.47	0.47	0.55	0.92	0.96	1.02	1.30	0.95	1.42	0.94	1.63	1.44	1.27
C7	0.98	0.81	0.65	1.00	0.72	0.91	0.87	0.80	0.63	0.75	1.56	0.46	0.67	0.96	1.24
C8	3.26	2.43	2.30	2.65	3.10	2.98	2.75	2.41	2.36	2.00	4.18	1.70	1.48	3.68	2.75
C9	3.51	2.80	2.77	3.37	3.46	4.23	4.02	4.21	4.16	2.74	5.93	3.47	3.15	3.36	3.99
C10	5.54	6.78	6.42	6.45	7.35	5.37	5.63	5.82	6.44	3.74	8.18	6.94	6.38	6.57	8.42
C11	4.68	0.75	0.53	0.93	0.94	4.46	7.10	5.02	5.81	2.66	5.12	5.31	4.50	3.20	7.44
C12	2.95	2.55	1.88	2.01	2.30	2.69	1.34	2.21	2.98	1.58	2.87	2.42	1.54	1.04	3.81
C13+	13.17	5.60	6.54	6.38	7.71	6.12	6.10	6.35	9.66	13.56	4.31	8.12	4.16	10.09	16.33
TOTAL	34.97	22.32	21.56	23.26	26.12	27.69	28.77	27.84	33.34	27.90	33.57	29.37	23.50	30.36	45.74

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Task 4. New Component Blends and Synergistic Effects
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
XC013DE catalyst at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT	BLEND A			BLEND B			BLEND C		
				Contact Time (s)	60	120	200	60	120	200	60	120	200
				Catalyst/oil	4.2	3.8	3.3	4.3	4.0	3.7	3.9	4.1	3.6
					M326	M327	M328	M321	M320	M322	M324	M325	M323
1	56	4	0		0.06	0.06	0.05	0.10	0.05	0.05	0.06	0.06	0.00
2	58	4	2	BUTANES	0.00	0.06	0.05	0.05	0.00	0.05	0.00	0.06	0.00
3	70	5	0		0.18	0.41	0.74	0.40	0.28	0.25	0.13	0.18	0.23
4	72	5	2	PENTANES	0.06	0.76	1.00	0.79	0.14	0.65	0.19	0.12	0.51
5	78	6	-6	BENZENE	0.80	0.70	0.58	2.14	1.67	1.40	2.33	2.06	2.26
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		0.86	0.99	1.22	0.79	0.65	0.55	0.97	0.55	0.45
8	84	4	-4	S THIOPHENE	0.12	0.06	0.11	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	1.17	2.73	2.85	2.48	1.53	2.54	1.36	1.03	1.58
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	0.98	0.81	0.90	1.94	2.04	1.50	2.14	1.94	2.14
12	96	7	-2		0.06	0.00	0.05	0.00	0.05	0.05	0.06	0.06	0.06
13	98	7	0		1.23	1.28	1.16	1.09	1.11	1.30	2.40	1.33	1.07
14	100	7	2	HEPTANES	2.65	4.07	4.49	3.73	1.39	3.29	1.62	2.06	1.47
15	106	8	-6	XYLENES	3.20	2.27	2.91	4.72	4.96	3.59	4.92	4.49	4.74
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		0.98	0.70	0.90	0.55	0.65	0.50	1.10	0.91	0.79
18	114	8	2	OCTANES	4.80	7.97	6.92	2.68	1.58	3.74	2.46	2.24	1.06
19	118	9	-8	INDANES	0.74	0.58	0.42	0.75	0.74	0.75	1.49	1.45	1.41
20	120	9	-6	C9 AB'S	2.77	2.21	2.27	4.27	4.87	4.14	4.40	4.30	4.29
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.06
23	128	9	2		2.03	3.31	1.95	1.04	0.93	2.34	1.30	1.27	0.79
24	128	10	-12	NAPHTHALENE	3.63	2.38	2.01	2.43	2.60	2.15	4.15	3.94	4.29
25	132	10	-8	INDANE	0.31	0.23	0.21	0.30	0.56	0.25	0.91	1.33	1.35
26	134	10	-6	C10 AB'S	1.60	1.16	1.06	2.88	3.15	2.84	2.40	2.36	2.20
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		2.15	2.15	2.01	0.84	0.51	1.25	0.39	0.79	0.34
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	4.18	2.79	2.54	3.53	3.76	3.19	6.09	5.76	5.70
31	146	11	-8		0.12	0.06	0.11	0.55	0.42	0.30	0.52	0.61	0.51
32	148	11	-6		0.37	0.52	0.42	0.75	0.56	0.75	1.04	1.03	0.34
33	154	11	0		0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.09	0.05	0.06	0.12	0.17
35	156	11	2	C11 PARAFFINS	1.54	1.80	1.53	0.40	0.19	1.00	1.62	0.97	0.17
36	156	12	-12	DIME NAPHTHALENES	2.95	2.27	2.01	2.43	2.88	2.29	4.99	4.18	4.62
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.00
38	162	12	-6		0.00	0.06	0.11	0.00	0.00	0.05	0.00	0.12	0.11
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.06
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.86	0.52	0.37	0.05	0.14	0.10	0.65	0.91	0.56
42	170	12	2		2.15	1.45	1.11	0.15	0.14	0.50	0.45	0.36	0.11
43	170	13	-12	ALKYL NAPHTHALENES	1.54	1.05	0.79	1.39	1.58	1.45	2.46	2.18	2.14
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	1.85	1.16	1.11	0.35	0.65	0.55	1.17	1.33	1.13
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.80	0.35	0.37	0.25	0.23	0.35	0.00	0.00	0.00
51	184	13	2		0.00	0.58	0.26	0.00	0.05	0.00	0.00	0.00	0.00
52	184	14	-12		0.80	0.35	0.37	0.60	0.28	0.35	0.97	0.85	0.45
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	1.91	1.45	1.22	0.60	1.02	0.90	1.55	1.88	1.52
56	194	15	-16		0.00	0.00	0.00	0.05	0.00	0.05	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.12	0.12	0.05	0.05	0.05	0.10	0.19	0.06	0.23
59	198	14	2		0.00	0.29	0.42	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.18	0.00	0.16	0.05	0.00	0.10	0.13	0.12	0.11
61	202	16	-22	PYRENE	0.31	0.23	0.21	0.10	0.23	0.15	0.39	0.42	0.28
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	1.78	1.22	1.11	0.55	1.07	0.70	1.17	1.21	1.07
64	210	15	0		0.00	0.00	0.00	1.49	1.35	0.90	1.81	1.21	1.52
65	212	15	2		0.00	0.17	0.37	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.62	0.58	0.53	0.15	0.23	0.10	0.52	0.55	0.56
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.68	0.58	0.53	0.25	0.14	0.30	0.39	0.42	0.34
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.37	0.17	0.26	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.12	0.06	0.05	0.00	0.05	0.00	0.06	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.62	0.29	0.32	0.20	0.23	0.15	0.45	0.36	0.23
76	234	17	-18		0.12	0.29	0.21	0.10	0.09	0.15	0.19	0.18	0.11
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.31	0.23	0.16	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.12	0.06	0.16	0.05	0.05	0.05	0.06	0.06	0.06
81	242	19	-20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.18	0.12	0.11	0.10	0.09	0.10	0.06	0.06	0.11
83	246	18	-6	TRIBUTYLBENZENE	0.53	0.29	0.37	0.00	0.05	0.00	0.19	0.00	0.73
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	1.05	0.76	0.69	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	56.61	54.95	51.88	48.33	45.05	47.89	62.05	57.77	54.82

Task 4. Key Component Blends and Synergistic Effects
Reactor Effluent Carbon Distribution
by
Hydrocarbon Types
XC013DE catalyst at a Reactor Temperature of 477C

	BLEND A			BLEND B			BLEND C		
Contact Time (s)	60	120	200	60	120	200	60	120	200
Catalyst/oil	4.2	3.8	3.3	4.3	4.0	3.7	3.9	4.1	3.6
	M326	M327	M328	M321	M320	M322	M324	M325	M323
PARAFFINS									
C1	0.29	0.38	0.46	0.71	0.82	0.54	0.37	0.39	0.51
C2	0.43	0.56	0.69	0.58	0.54	0.54	0.41	0.38	0.54
C3	1.37	1.64	1.93	2.63	2.81	2.56	2.50	2.12	2.83
C4	9.95	10.50	11.18	14.99	17.13	17.99	13.11	12.73	14.21
C5	9.01	9.77	10.49	11.36	11.82	12.16	7.88	9.85	10.36
C6	2.71	4.26	4.52	4.35	3.55	4.38	2.48	2.59	3.12
C7	3.39	4.65	5.12	4.41	2.04	3.83	1.97	2.77	2.11
C8	4.80	7.97	6.92	2.68	1.58	3.74	2.46	2.24	1.86
C9	2.03	3.31	1.95	1.04	0.93	2.34	1.30	1.27	0.79
C10	2.15	2.15	2.01	0.84	0.51	1.25	0.39	0.79	0.34
C11	1.54	1.80	1.53	0.40	0.19	1.00	1.62	0.97	0.17
C12	2.15	1.45	1.11	0.15	0.14	0.50	0.45	0.36	0.11
C13+	1.72	2.21	2.17	0.00	0.05	0.00	0.00	0.00	0.00
TOTAL	41.56	50.65	50.09	44.15	42.09	50.84	34.93	36.47	36.95
OLEFINS									
C2	0.22	0.28	0.35	0.58	0.56	0.45	0.17	0.31	0.53
C3	6.23	6.43	6.58	8.31	7.88	6.65	5.11	5.91	5.85
C4	5.72	5.68	5.59	5.20	5.07	4.10	2.83	3.68	3.15
C5	1.57	1.69	1.94	1.23	1.20	0.85	0.49	0.77	0.73
C6	1.23	1.29	1.53	1.10	0.92	0.76	1.13	0.81	0.71
C7	1.23	1.28	1.16	1.26	1.11	1.30	2.40	1.33	1.07
C8	0.98	0.70	0.90	0.55	0.65	0.50	1.10	0.91	0.79
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.06
C10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13+	0.00	0.00	0.00	1.49	1.35	0.90	1.81	1.21	1.52
TOTAL	17.19	17.53	18.06	19.72	18.72	15.51	15.04	15.05	14.41
cycloOLEFINS									
C5	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.04	0.04
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
C7	0.06	0.00	0.05	0.03	0.05	0.05	0.06	0.06	0.10
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.06	0.01	0.07	0.03	0.05	0.05	0.06	0.10	0.21
AROMATICS									
C6	0.88	0.76	0.65	2.32	1.87	1.53	2.43	2.31	2.45
C7	0.98	0.81	0.90	1.99	2.09	1.58	2.14	1.99	2.20
C8	3.26	2.27	2.91	4.72	4.96	3.59	4.92	4.49	4.74
C9	3.51	2.79	2.69	5.02	5.61	4.89	5.89	5.76	5.70
C10	5.54	3.78	3.28	5.61	6.31	5.24	7.45	7.64	7.84
C11	4.68	3.37	3.06	4.82	4.73	4.24	7.64	7.40	6.54
C12	2.95	2.33	2.11	2.43	2.97	2.39	5.12	4.55	4.91
C13+	13.17	8.72	8.03	4.87	6.17	5.69	10.62	10.61	9.70
TOTAL	34.97	24.83	23.63	31.79	34.72	29.15	46.22	44.74	44.08

PETRO-CANADA
Research & Development

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Blend A cracked over catalyst FC0120E at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT									
				Carbon on Catalyst (%)	0.11			0.27			0.48		
				Contact Time (s)	60	120	200	60	120	200	60	120	200
				Catalyst/oil	4.2	3.9	4.5	4.2	3.6	4.4	4.0	4.0	4.1
					M353	M357	M359	M345	M361	M350	M336	M340	M342
1	56	4	0		0.06	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.00
2	58	4	2	BUTANES	0.06	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.00
3	70	5	0		1.30	0.72	1.19	0.50	1.56	0.67	0.52	0.75	0.80
4	72	5	2	PENTANES	1.66	0.70	0.95	0.56	6.33	0.57	0.59	0.52	0.48
5	78	6	-6	BENZENE	0.47	0.38	0.57	0.31	0.32	0.41	0.33	0.11	0.32
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		2.19	3.08	4.57	2.00	3.75	1.70	2.08	2.41	2.40
8	84	4	-4	S THIOPHENE	0.06	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05
9	86	6	2	HEXANES	5.91	4.17	5.76	3.13	3.54	3.03	3.25	2.87	2.83
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	0.47	0.54	0.62	0.44	1.02	0.82	0.46	0.63	0.64
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	98	7	0		2.31	2.22	1.90	1.06	2.04	1.54	1.11	1.61	1.23
14	100	7	2	HEPTANES	5.91	5.03	3.14	4.57	5.15	4.01	4.75	4.47	4.06
15	106	8	-6	XYLENES	1.30	1.19	1.62	0.94	2.95	1.90	0.98	0.86	0.80
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		2.54	1.51	1.90	1.56	2.20	1.44	1.63	1.43	1.44
18	114	8	2	OCTANES	12.12	9.25	8.99	8.19	8.26	6.38	8.52	7.57	6.72
19	118	9	-8	INDANES	0.12	0.38	0.29	0.63	0.48	0.26	0.65	0.40	0.32
20	120	9	-6	C9 AB'S	0.83	1.35	1.28	1.31	2.20	1.49	1.37	1.49	1.28
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.38	0.38	0.25	0.75	0.36	0.26	0.46	0.32
23	128	9	2		5.30	4.49	3.52	2.38	3.54	2.47	2.47	2.75	2.56
24	128	10	-12	NAPHTHALENE	0.65	1.24	1.19	2.25	1.61	2.31	2.34	1.95	2.19
25	132	10	-8	INDANE	0.06	0.05	0.00	0.06	0.11	0.00	0.07	0.06	0.00
26	134	10	-6	C10 AB'S	0.53	0.60	0.10	1.06	1.07	0.62	1.11	0.75	0.69
27	140	10	0		0.00	0.54	0.33	0.63	1.02	0.57	0.65	0.46	0.53
28	142	10	2		3.61	2.60	1.95	1.75	1.93	1.08	1.82	1.38	1.17
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.64	2.61
30	142	11	-12	ME NAPHTHALENES	0.35	0.87	0.81	2.50	0.97	2.42	2.60	0.00	0.00
31	146	11	-8		0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	148	11	-6		0.18	0.05	0.24	0.81	0.38	0.62	0.85	0.86	0.43
33	154	11	0		0.00	0.54	0.29	0.81	0.86	0.51	0.85	0.80	0.53
34	154	12	-14		0.00	0.16	0.05	0.13	0.11	0.15	0.13	0.23	0.11
35	156	11	2	C11 PARAFFINS	2.01	1.51	0.95	1.25	1.02	0.82	1.30	0.06	1.07
36	156	12	-12	DIME NAPHTHALENES	0.53	0.16	0.43	2.25	0.48	2.16	2.34	2.18	2.19
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.12	0.16	0.05	0.00	0.11	0.10	0.00	0.23	0.27
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.53	0.54	0.10	0.56	0.32	0.15	0.59	0.52	0.43
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.18	0.27	0.05	0.69	0.11	0.41	0.72	0.69	0.75
42	170	12	2		0.89	0.97	0.86	1.00	0.70	0.46	1.04	0.86	0.69
43	170	13	-12	ALKYL NAPHTHALENES	0.35	0.54	0.14	1.81	0.27	1.39	1.89	1.66	1.55
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.18	0.27	0.14	1.13	0.16	0.77	1.17	0.92	1.29
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.12	0.11	0.00	0.56	0.05	0.10	0.59	0.23	0.27
51	184	13	2		0.71	0.92	0.38	0.13	0.54	0.31	0.13	0.57	0.48
52	184	14	-12		0.06	0.27	0.10	0.94	0.11	0.46	0.98	0.92	1.17
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.18	0.38	0.14	1.31	0.16	1.39	1.37	0.52	1.28
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.06	0.11	0.00	0.19	0.00	0.10	0.20	0.23	0.05
59	198	14	2		0.41	0.49	0.05	0.25	0.00	0.26	0.26	0.34	0.16
60	198	15	-12		0.00	0.00	0.00	0.25	0.05	0.15	0.26	0.40	0.05
61	202	16	-22	PYRENE	0.06	0.11	0.00	0.13	0.00	0.21	0.13	0.23	0.21
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.12	0.27	0.05	1.13	0.54	0.87	1.17	0.75	0.80
64	210	15	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00
65	212	15	2		0.12	0.32	0.00	0.31	0.00	0.21	0.33	0.40	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.12	0.11	0.00	0.63	0.11	0.51	0.65	0.63	0.64
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.06	0.05	0.00	0.69	0.05	0.46	0.72	0.40	0.37
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.18	0.16	0.00	0.06	0.00	0.00	0.07	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.06	0.05	0.00	0.38	0.00	0.36	0.39	0.46	0.37
76	234	17	-18		0.06	0.00	0.00	0.19	0.00	0.10	0.20	0.40	0.21
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.12	0.11	0.05	0.00	0.00	0.15	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.38	0.05	0.15	0.39	0.75	0.43
80	242	19	-24		0.00	0.00	0.00	0.13	0.00	0.10	0.13	0.29	0.11
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.06	0.00	0.00	0.19	0.00	0.15	0.20	0.11	0.11
83	246	18	-6	TRIBUTYLBENZENE	0.30	0.22	0.10	0.50	0.38	0.36	0.52	0.92	0.37
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.83	0.65	0.29	1.13	0.59	0.67	1.17	0.97	0.80
86	254	AND OTHER		UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	56.66	51.12	45.49	55.98	58.04	48.76	58.23	54.24	50.64

P E T R O - C A N A D A
Research & Development

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Effluent Carbon Distribution
by
Hydrocarbon Types
Blend A cracked over catalyst IC013DE at a Reactor Temperature of 477C

Carbon on Catalyst (%)	0.11			0.27			0.48		
Contact Time (s)	60	120	200	60	120	200	60	120	200
Catalyst/oil	4.2	3.9	4.5	4.2	3.6	4.4	4.0	4.0	4.1
	M353	M357	M359	M345	M361	M350	M336	M340	M342
PARAFFINS									
C1	0.23	0.39	0.55	0.28	0.34	0.49	0.21	0.36	0.32
C2	0.44	0.78	1.00	0.56	0.73	0.81	0.44	0.75	0.59
C3	1.08	1.36	1.94	1.22	1.21	1.64	0.97	1.32	1.23
C4	8.42	8.78	10.31	8.38	7.50	9.75	7.07	7.94	8.25
C5	11.09	10.95	12.28	9.03	14.30	10.66	7.82	8.19	9.89
C6	7.73	6.45	8.36	4.64	4.99	5.07	4.65	4.11	5.01
C7	7.05	6.22	4.11	5.21	5.92	4.85	5.31	5.01	5.14
C8	12.12	9.25	8.99	8.19	8.26	6.38	8.52	7.57	6.72
C9	5.50	4.49	3.52	2.38	3.54	2.47	2.47	2.75	2.56
C10	3.61	2.60	1.95	1.75	1.93	1.08	1.82	1.38	1.17
C11	2.01	1.51	0.95	1.25	1.02	0.82	1.30	0.06	1.07
C12	0.89	0.97	0.86	1.00	0.70	0.46	1.04	0.86	0.69
C13+	2.37	2.65	0.76	1.88	1.13	1.59	1.95	2.29	1.44
TOTAL	62.56	56.41	55.59	45.78	51.58	46.08	43.58	42.59	44.08
OLEFINS									
C2	0.18	0.43	0.59	0.29	0.45	0.42	0.20	0.42	0.25
C3	5.98	7.09	7.62	6.84	6.52	7.43	6.29	7.32	6.80
C4	5.82	6.74	6.49	6.88	6.39	6.82	6.76	7.22	6.88
C5	3.41	3.45	3.20	2.79	3.73	2.77	3.15	3.07	3.57
C6	2.85	3.83	5.17	2.53	4.31	2.20	2.72	2.89	3.15
C7	2.31	2.22	2.31	1.06	2.04	1.54	1.11	1.61	1.23
C8	2.54	1.51	1.90	1.56	2.20	1.44	1.63	1.43	1.44
C9	0.00	0.38	0.38	0.25	0.75	0.36	0.26	0.46	0.32
C10	0.00	0.54	0.33	0.63	1.02	0.57	0.65	0.46	0.53
C11	0.00	0.54	0.29	0.81	0.86	0.51	0.85	0.80	0.53
C12	0.53	0.54	0.10	0.56	0.32	0.15	0.59	0.52	0.43
C13+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00
TOTAL	23.61	27.27	28.36	24.21	28.59	24.21	24.19	26.36	25.12
cycloOLEFINS									
C5	0.02	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.02	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.00
AROMATICS									
C6	0.57	0.48	0.67	0.36	0.39	0.49	0.38	0.16	0.42
C7	0.47	0.54	0.62	0.44	1.02	0.82	0.46	0.63	0.64
C8	1.30	1.19	1.62	0.94	2.95	1.90	0.98	0.86	0.89
C9	0.95	1.73	1.57	1.94	2.68	1.75	2.02	1.89	1.60
C10	1.24	1.89	1.28	3.38	2.79	2.93	3.51	5.39	5.50
C11	0.59	0.92	1.05	3.32	1.34	3.03	3.45	0.86	0.43
C12	0.65	0.49	0.52	2.38	0.70	2.42	2.47	2.64	2.56
C13+	1.95	2.76	0.71	11.20	2.04	8.08	11.65	10.49	10.03
TOTAL	7.72	10.00	8.05	23.95	13.91	21.42	24.91	22.92	22.07

P E T R O - C A N A D A
Research & Development

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Blend B cracked over catalyst ICO1IDE at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT	0.11			0.27			0.48		
					60	120	200	60	120	200	60	120	200
					4.0	3.8	3.9	4.0	3.9	4.0	3.7	3.7	4.2
					M352	M354	M356	M346	M349	M351	M330	M329	M333
1	56	4	0		0.15	0.00	0.13	0.07	0.00	0.13	0.00	0.00	0.10
2	58	4	2	BUTANES	0.15	0.00	0.13	0.07	0.00	0.06	0.00	0.00	0.05
3	70	5	0		1.70	0.95	1.58	0.40	0.29	0.32	0.72	0.83	0.25
4	72	5	2	PENTANES	2.22	2.07	2.40	1.33	0.70	1.79	0.85	1.22	1.41
5	78	6	-6	BENZENE	1.41	1.12	0.82	1.00	1.70	1.40	2.02	1.28	1.11
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		2.74	2.07	2.90	1.33	1.17	2.49	2.41	2.37	1.97
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	0.74	7.16	8.08	4.14	3.51	7.66	3.59	4.49	6.05
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	0.89	0.83	0.69	0.47	0.94	0.64	0.78	1.22	0.50
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.06	0.20	0.13	0.05
13	98	7	0		4.15	3.43	3.03	2.00	2.51	3.83	3.00	2.95	3.03
14	100	7	2	HEPTANES	9.56	8.82	8.77	5.47	5.09	8.62	3.52	5.13	6.81
15	106	8	-6	XYLENES	2.15	2.25	2.40	1.00	2.40	1.60	1.89	3.27	1.26
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		2.82	2.43	3.28	1.80	1.99	2.62	2.02	1.60	2.07
18	114	8	2	OCTANES	9.12	7.58	6.31	4.80	4.44	7.40	3.59	5.65	5.85
19	118	9	-8	INDANES	0.30	0.53	0.32	0.53	0.47	0.26	1.11	1.15	0.20
20	120	9	-6	C9 AB'S	1.70	1.83	2.27	1.60	1.40	1.34	2.74	3.53	1.06
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.74	0.24	0.32	0.27	0.12	0.38	0.78	0.13	0.30
23	128	9	2		6.22	4.56	3.28	3.40	2.75	4.60	3.78	3.40	3.63
24	128	10	-12	NAPHTHALENE	1.26	0.83	1.01	2.67	2.75	1.28	2.35	2.25	1.01
25	132	10	-8	INDANE	0.22	0.24	0.25	0.20	0.18	0.19	0.26	0.26	0.15
26	134	10	-6	C10 AB'S	0.74	0.71	0.69	0.40	1.87	0.64	2.02	2.44	0.50
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
28	142	10	2		3.71	2.66	2.90	2.20	1.93	2.49	2.28	1.60	1.97
29	142	10	-12		0.67	0.65	1.01	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	0.00	0.00	0.00	4.00	3.63	0.83	2.61	2.57	0.66
31	146	11	-8		0.15	0.12	0.00	0.33	0.29	0.19	0.52	0.26	0.15
32	148	11	-6		0.52	0.12	0.44	1.87	0.94	0.32	1.17	0.38	0.25
33	154	11	0		0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.06	0.00
35	156	11	2	C11 PARAFFINS	1.85	1.24	0.76	2.47	0.76	1.02	1.69	1.80	0.81
36	156	12	-12	DIME NAPHTHALENES	0.67	0.53	0.82	3.20	2.92	0.57	1.43	1.54	0.45
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.15	0.00	0.00	0.07	0.12	0.06	0.00	0.00	0.05
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.15	0.12	0.13	0.87	0.58	0.13	0.59	0.13	0.10
42	170	12	2		1.04	0.77	0.76	1.73	0.94	0.13	1.30	0.71	0.10
43	170	13	-12	ALKYL NAPHTHALENES	0.30	0.12	0.32	1.94	1.58	0.32	0.78	0.64	0.25
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.15	0.12	0.13	0.87	0.58	0.19	0.65	0.45	0.15
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.07	0.06	0.06	1.40	0.76	0.13	0.33	0.13	0.10
51	184	13	2		0.07	0.12	0.06	0.67	0.35	0.13	0.13	0.00	0.10
52	184	14	-12		0.15	0.12	0.06	0.60	0.35	0.19	0.52	0.26	0.15
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.15	0.12	0.13	1.33	1.17	0.26	0.13	0.32	0.20
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.07	0.06	0.06	0.47	0.58	0.06	0.13	0.06	0.05
59	198	14	2		0.00	0.00	0.00	0.27	0.18	0.00	0.00	0.00	0.00
60	198	15	-12		0.07	0.00	0.00	0.60	0.23	0.06	0.13	0.00	0.05
61	202	16	-22	PYRENE	0.07	0.00	0.06	0.33	0.18	0.00	0.20	0.06	0.00
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.15	0.12	0.06	1.07	0.99	0.26	0.52	0.26	0.20
64	210	15	0		2.96	2.72	1.31	2.14	1.87	1.60	4.89	0.37	1.26
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.73	0.47	0.13	0.00	0.00	0.10
68	216	17	-22	ME PYRENE	0.07	0.06	0.06	0.00	0.00	0.00	0.13	0.06	0.00
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.15	0.06	0.06	0.47	0.35	0.13	0.13	0.06	0.10
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.00	0.00	0.06	0.47	0.29	0.00	0.13	0.06	0.00
76	234	17	-18		0.00	0.00	0.00	0.13	0.12	0.00	0.07	0.00	0.00
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.06	0.27	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.00	0.00	0.06	0.07	0.06	0.00	0.00	0.00	0.00
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.00	0.00	0.13	0.12	0.00	0.07	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.15	0.36	0.19	0.53	0.47	0.26	1.17	1.28	1.00
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.60	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.15	0.71	0.19	0.00	0.29	0.64	0.00	0.00	0.58
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	62.62	58.59	58.62	64.19	57.36	57.78	61.21	58.31	46.14

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Reactor Effluent Carbon Distribution
by
Hydrocarbon Types
Blend B cracked over catalyst XC013DE at a Reactor Temperature of 477C

Carbon on Catalyst (%)		0.11			0.27			0.48	
Contact Time (s)		60	120	200	60	120	200	60	120	200
Catalyst/oil		4.0	3.8	3.9	4.0	3.9	4.0	3.7	3.7	4.2
		M352	M354	M356	M346	M349	M351	M330	M329	M333
PARAFFINS										
	C1	0.17	0.18	0.28	0.11	0.19	0.27	0.17	0.22	0.40
	C2	0.22	0.24	0.35	0.18	0.26	0.35	0.21	0.29	0.41
	C3	1.02	1.11	1.69	0.81	1.13	1.43	0.77	1.07	1.47
	C4	12.79	12.72	14.59	11.46	13.44	14.17	10.80	11.87	13.28
	C5	10.62	12.71	11.83	9.70	11.00	11.61	9.47	10.84	14.33
	C6	2.11	9.15	9.56	5.61	5.33	9.31	5.21	6.43	9.52
	C7	10.06	9.88	9.28	6.20	5.86	9.23	4.14	5.88	8.10
	C8	9.12	7.58	6.31	4.80	4.44	7.40	3.59	5.65	5.85
	C9	6.22	4.56	3.28	3.40	2.75	4.60	3.78	3.40	3.63
	C10	3.71	2.66	2.90	2.20	1.93	2.49	2.28	1.60	1.97
	C11	1.85	1.24	0.76	2.47	0.76	1.02	1.69	1.80	0.81
	C12	1.04	0.77	0.76	1.73	0.94	0.13	1.30	0.71	0.10
	C13+	0.22	0.83	0.25	0.93	0.82	0.77	1.50	1.67	0.61
	TOTAL	59.15	63.64	61.85	49.62	48.85	62.79	44.92	51.42	60.47
OLEFINS										
	C2	0.13	0.11	0.25	0.05	0.10	0.19	0.06	0.11	0.14
	C3	5.44	5.27	5.24	4.74	5.84	5.57	5.75	5.79	7.16
	C4	4.28	3.69	3.54	3.85	4.46	3.89	5.22	4.74	5.49
	C5	2.45	1.53	2.15	1.08	1.13	0.93	2.18	1.87	1.83
	C6	2.97	2.45	3.13	1.62	1.48	2.75	2.82	2.77	2.62
	C7	4.15	3.88	3.03	2.28	2.51	3.83	3.00	3.27	3.50
	C8	2.82	2.43	3.28	1.80	1.99	2.62	2.02	1.60	2.07
	C9	0.74	0.24	0.32	0.27	0.12	0.38	0.78	0.13	0.30
	C10	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
	C11	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
	C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C13+	2.96	2.72	1.51	2.14	1.87	1.60	4.89	0.37	1.26
	TOTAL	25.95	22.32	22.44	17.81	19.49	21.75	27.05	20.67	24.37
cycloOLEFINS										
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C7	0.00	0.00	0.00	0.00	0.00	0.06	0.20	0.13	0.05
	C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	0.00	0.00	0.00	0.00	0.00	0.06	0.22	0.15	0.05
AROMATICS										
	C6	1.49	1.30	0.90	1.13	1.82	1.52	2.14	1.41	1.48
	C7	0.89	0.83	0.69	0.47	0.94	0.64	0.78	1.22	0.61
	C8	2.15	2.33	2.40	1.06	2.40	1.60	1.89	3.35	1.26
	C9	2.00	2.37	2.59	2.14	1.87	1.60	3.85	4.68	1.26
	C10	2.89	2.43	2.97	3.27	4.79	2.11	4.63	4.94	1.66
	C11	0.67	0.24	0.44	6.21	4.85	1.34	4.30	3.21	1.06
	C12	0.82	0.53	0.82	3.27	3.04	0.64	1.63	1.60	0.50
	C13+	1.70	1.30	1.51	12.20	8.89	2.11	5.67	4.04	2.46
	TOTAL	12.61	11.32	12.32	29.82	28.60	11.54	24.89	24.46	10.30

P E T R O - C A N A D A
Research & Development

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Blend C cracked over catalyst XCL100E at a Reactor Temperature of 477C

ENTRY	MASS	C #	Z #	COMPONENT	0.11			0.27			0.48		
					60	120	200	60	120	200	60	120	200
					3.9	3.8	3.9	3.7	3.8	4.0	3.7	3.8	3.9
					M358	M360	M362	M339	M341	M343	M334	M335	M344
1	56	4	0		0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.07
2	58	4	2	BUTANES	0.21	0.00	0.07	0.00	0.00	0.00	0.00	0.06	0.07
3	70	5	0		1.21	0.24	0.40	0.19	0.26	0.41	0.29	1.03	0.40
4	72	5	2	PENTANES	2.36	0.47	1.00	0.45	0.21	0.82	0.66	1.55	1.19
5	78	6	-6	BENZENE	2.43	2.01	2.14	0.45	0.98	1.82	1.18	2.19	2.06
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		2.43	1.30	1.40	0.71	0.41	1.53	2.14	2.39	1.46
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	7.21	4.25	4.21	2.39	2.18	3.71	4.20	6.32	5.11
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	1.29	0.89	1.47	0.45	0.31	1.65	0.81	1.48	1.79
12	96	7	-2		0.00	0.12	0.00	0.13	0.00	0.00	0.15	0.06	0.00
13	98	7	0		4.28	2.78	2.94	2.20	1.35	2.18	3.02	3.67	3.32
14	100	7	2	HEPTANES	8.64	6.00	5.35	4.66	3.27	4.94	6.71	8.06	6.51
15	106	8	-6	XYLENES	2.29	1.18	2.27	0.71	2.44	2.88	1.47	2.71	3.32
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		3.28	2.72	2.47	2.20	1.97	1.77	2.65	2.32	2.39
18	114	8	2	OCTANES	8.43	6.02	5.08	4.53	2.64	4.30	6.27	7.35	6.11
19	118	9	-8	INDANES	0.93	0.53	0.67	0.71	1.30	0.47	0.59	0.77	0.73
20	120	9	-6	C9 AB'S	1.86	1.71	2.21	1.42	3.11	1.94	1.55	1.61	2.12
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.43	1.00	1.67	0.84	0.47	0.24	0.66	0.52	0.46
23	128	9	2		5.36	3.19	2.68	3.04	1.81	2.53	2.80	4.77	2.85
24	128	10	-12	NAPHTHALENE	2.86	3.60	2.81	3.75	2.49	2.65	3.91	2.71	3.39
25	132	10	-8	INDANE	1.07	0.53	1.00	0.71	0.88	0.41	0.66	0.39	1.00
26	134	10	-6	C10 AB'S	0.93	0.89	0.74	1.36	2.23	0.24	0.59	0.71	1.19
27	140	10	0		0.57	0.24	0.27	0.13	0.16	0.00	0.22	0.13	0.20
28	142	10	2		1.86	0.83	0.94	0.00	0.00	0.00	0.96	2.26	1.06
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	1.79	4.19	3.88	4.85	3.94	3.77	3.98	1.81	1.93
31	146	11	-8		0.29	0.47	0.74	0.52	0.31	0.06	0.44	0.13	0.86
32	148	11	-6		0.57	0.83	0.87	1.10	1.14	0.41	0.66	0.26	0.66
33	154	11	0		0.14	0.24	0.40	0.32	0.16	0.12	0.15	0.00	0.20
34	154	12	-14		0.07	0.12	0.13	0.32	0.16	0.29	0.22	0.06	0.13
35	156	11	2	C11 PARAFFINS	1.07	0.41	0.60	0.97	0.47	1.18	0.74	1.68	0.53
36	156	12	-12	DIME NAPHTHALENES	1.07	3.07	3.28	3.17	3.68	3.47	2.36	0.84	3.65
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.14	0.06	0.07	0.26	0.00	0.18	0.15	0.00	0.13
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.14	0.30	0.74	1.10	0.52	0.18	0.44	0.13	0.33
42	170	12	2		0.57	0.65	0.67	1.10	0.41	1.00	0.52	0.13	0.20
43	170	13	-12	ALKYL NAPHTHALENES	0.36	1.12	2.01	1.81	1.92	1.82	1.25	0.32	1.00
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.21	0.53	1.27	1.49	0.73	1.29	1.03	0.19	0.66
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.00	0.30	1.07	1.62	0.52	0.77	0.81	0.00	0.00
51	184	13	2		0.14	0.00	0.00	0.19	0.05	0.24	0.07	0.19	0.20
52	184	14	-12		0.07	0.30	0.67	1.36	0.57	0.59	0.37	0.06	0.20
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.07	0.53	1.47	1.75	0.93	1.29	0.88	0.13	0.86
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.00	0.06	0.27	0.32	0.21	0.24	0.29	0.00	0.13
59	198	14	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.00	0.12	0.29	0.26	0.21	0.24	0.22	0.00	0.20
61	202	16	-22	PYRENE	0.00	0.06	0.27	0.32	0.21	0.29	0.37	0.00	0.07
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.07	0.30	0.74	1.10	0.73	1.00	1.11	0.06	0.46
64	210	15	0		2.36	2.13	2.07	2.46	1.09	0.88	3.98	2.32	1.46
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.07	0.12	0.33	0.58	0.52	0.65	0.74	0.00	0.13
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.00	0.06	0.27	0.52	0.31	0.41	0.66	0.00	0.07
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.00	0.00	0.27	0.39	0.26	0.41	0.37	0.00	0.07
76	234	17	-18		0.30	0.00	0.07	0.19	0.10	0.12	0.15	0.00	0.00
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.06	0.33	0.00	0.21	0.12	0.37	0.00	0.20
80	242	19	-24		0.00	0.00	0.07	0.06	1.14	1.29	0.15	0.00	0.00
81	242	19	-20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.00	0.07	0.13	0.10	0.12	0.22	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.21	0.35	0.40	0.13	0.52	0.24	1.47	0.52	1.26
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.07	0.12	0.20	0.39	0.10	0.06	0.22	0.13	0.20
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	364	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTALS:	69.55	57.06	65.21	60.00	49.66	57.20	65.93	62.08	62.60

Task 5. The Effects of Residual Catalyst Coke on Cracking Yields
Reactor Reactor Effluent Carbon Distribution
by
Hydrocarbon Types
Blend C cracked over catalyst XC013DE at a Reactor Temperature of 477C

Carbon on Catalyst (%)	0.11			0.27			0.48		
Contact Time (s)	60	120	200	60	120	200	60	120	200
Catalyst/oil	3.9	3.8	3.9	3.7	3.8	4.0	3.7	3.8	3.9
	M358	M360	M362	M339	M341	M343	M334	M335	M344
PARAFFINS									
C1	0.12	0.23	0.34	0.18	0.44	0.29	0.16	0.19	0.24
C2	0.18	0.31	0.38	0.26	0.50	0.37	0.23	0.30	0.33
C3	1.01	1.22	1.43	1.11	1.45	1.74	0.74	1.33	1.63
C4	10.18	11.15	10.23	11.26	12.20	13.50	8.26	11.90	12.75
C5	9.48	11.64	8.71	10.75	12.06	10.36	9.07	11.12	10.00
C6	8.35	6.68	5.50	4.53	4.95	5.19	6.01	7.94	6.44
C7	9.16	7.27	5.80	5.60	4.32	5.53	7.49	8.82	7.00
C8	8.43	6.02	5.08	4.53	2.64	4.30	6.27	7.35	6.11
C9	5.36	3.19	2.68	3.04	1.81	2.53	2.80	4.77	2.85
C10	1.86	0.83	0.94	0.00	0.00	0.00	0.96	2.26	1.06
C11	1.07	0.41	0.60	0.97	0.47	1.18	0.74	1.68	0.53
C12	0.57	0.65	0.67	1.10	0.41	1.00	0.52	0.13	0.20
C13+	0.21	0.12	0.20	0.58	0.16	0.29	0.29	0.32	0.40
TOTAL	55.97	49.73	42.54	43.91	41.43	46.27	43.53	58.11	49.54
OLEFINS									
C2	0.14	0.10	0.24	0.11	0.26	0.25	0.09	0.17	0.24
C3	4.05	5.41	4.62	5.47	7.62	5.71	4.77	4.79	4.68
C4	3.09	3.95	3.11	4.05	5.40	4.03	4.09	3.40	2.97
C5	1.55	1.02	0.92	0.90	1.59	1.02	1.52	1.45	0.79
C6	2.65	1.78	1.62	1.11	1.01	1.79	2.59	2.68	1.69
C7	4.52	3.19	2.94	2.61	1.89	2.18	3.02	4.04	3.32
C8	3.28	2.72	2.47	2.20	1.97	1.77	2.65	2.32	2.39
C9	0.43	1.00	1.67	0.84	0.47	0.24	0.66	0.52	0.46
C10	0.57	0.24	0.27	0.13	0.16	0.00	0.22	0.13	0.20
C11	0.14	0.24	0.40	0.32	0.16	0.12	0.15	0.00	0.20
C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13+	2.36	2.13	2.07	2.46	1.09	0.88	3.98	2.32	1.46
TOTAL	22.77	21.75	20.35	20.21	21.60	17.98	23.75	21.82	18.41
cycloOLEFINS									
C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.00	0.12	0.00	0.13	0.00	0.00	0.15	0.06	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.12	0.00	0.13	0.00	0.00	0.15	0.06	0.00
AROMATICS									
C6	2.54	2.30	2.27	0.66	1.35	1.98	1.36	2.35	2.16
C7	1.29	0.89	1.47	0.45	0.31	1.65	0.81	1.48	1.79
C8	2.29	1.28	2.34	0.71	2.58	2.96	1.47	2.71	3.32
C9	2.78	2.24	2.88	2.13	4.41	2.41	2.14	2.39	2.85
C10	4.86	5.02	4.55	5.82	5.60	3.30	5.16	3.80	5.50
C11	2.64	5.49	5.48	6.47	5.39	4.24	5.09	2.19	3.45
C12	1.29	3.25	3.48	3.75	3.84	3.94	2.73	0.90	3.92
C13+	1.21	4.19	10.50	13.13	9.69	11.06	10.91	1.42	5.64
TOTAL	18.89	24.67	32.97	33.12	33.17	31.53	29.68	17.25	28.71

Task 5. Hydrothermal Deactivation of Cracking Catalyst
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Blend 4

					Steamed									Thermal							
				Deactivation Period	8 h			16 h			32 h			4 h			8 h			[illegible]	
				Catalyst/Oil	3.7	4.0	3.6	4.0	3.6	3.8	4.1	3.8	4.2	3.6	4.2	4.5	3.6	4.0	3.6	3.8	4.0
				Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S
				File Reference	M674	M676	M675	M680	M681	M682	M677	M678	M679	M661	M658	M660	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ENTRY	MASS	C #	Z #	COMPONENT																	
1	56	4	0		0.00	0.00	0.00	0.05	0.10	0.04	0.05	0.10	0.04	0.04	0.04	0.03	0.05	0.04	0.04	0.04	0.02
2	58	4	2	BUTANES	0.00	0.00	0.00	0.05	0.05	0.04	0.05	0.05	0.04	0.04	0.04	0.03	0.05	0.04	0.04	0.04	0.03
3	70	5	0		0.16	0.18	0.15	0.37	0.48	0.36	0.31	0.40	0.24	0.47	0.32	0.42	0.29	0.22	0.40	0.30	0.20
4	72	5	2	PENTANES	0.81	0.56	0.51	1.26	1.15	0.94	1.21	1.06	0.68	1.09	1.00	0.82	1.02	1.02	1.16	0.82	0.74
5	78	6	-6	BENZENE	0.42	0.32	0.37	0.42	0.38	0.40	0.43	0.40	0.32	0.63	0.57	0.28	0.49	0.49	0.45	0.37	0.24
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		0.93	0.56	0.57	1.10	0.82	0.76	1.13	0.86	0.63	0.76	0.89	0.66	0.58	0.84	0.85	0.61	0.67
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	[illegible]
9	86	6	2	HEXANES	3.58	2.64	3.10	4.08	3.70	3.86	4.02	3.72	2.94	3.38	3.11	2.45	3.55	3.46	3.80	3.11	[illegible]
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
11	92	7	-6	TOLUENE	1.14	0.81	1.13	1.05	0.91	1.17	1.02	0.91	0.92	0.95	0.89	0.68	1.07	1.11	1.16	1.13	0.97
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	98	7	0		1.33	0.95	0.95	1.37	1.25	1.21	1.41	1.21	0.82	0.83	0.89	0.67	0.97	1.13	1.25	0.78	0.84
14	100	7	2	HEPTANES	4.25	3.13	3.56	5.02	4.33	4.58	5.03	4.38	3.62	3.98	3.29	2.49	4.33	3.81	3.93	4.03	3.15
15	106	8	-6	XYLENES	3.06	2.25	2.84	2.87	2.60	3.05	2.79	2.31	2.27	2.48	2.36	1.73	2.53	2.61	2.77	2.34	2.11
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		1.40	0.88	1.10	1.52	1.15	1.35	1.55	1.16	1.04	1.06	0.68	0.49	1.22	0.84	0.85	1.16	0.74
18	114	8	2	OCTANES	7.02	4.26	4.65	7.94	5.87	5.92	6.45	6.14	4.74	4.84	3.90	3.12	5.98	5.05	5.58	5.11	3.79
19	118	9	-8	INDANES	0.42	0.21	0.24	0.63	0.38	0.40	0.58	0.35	0.29	0.40	0.18	0.13	0.53	0.27	0.27	0.46	0.20
20	120	9	-6	C9 AB'S	2.34	2.04	2.32	2.82	2.74	2.83	2.81	2.72	2.17	2.87	2.18	1.77	2.87	2.35	2.68	2.69	1.98
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	128	9	2		3.10	1.79	2.00	3.61	2.35	2.36	3.84	2.67	2.12	1.92	1.50	1.06	2.48	2.08	2.05	2.17	1.64
24	128	10	-12	NAPHTHALENE	1.66	1.37	1.43	1.88	1.88	1.79	1.99	1.96	1.45	1.77	1.29	0.97	2.04	1.59	1.70	1.43	1.01
25	132	10	-8	INDANE	0.41	0.25	0.26	0.47	0.34	0.31	0.47	0.35	0.26	0.30	0.25	0.22	0.24	0.22	0.27	0.16	0.13
26	134	10	-6	C10 AB'S	1.64	1.16	1.40	1.78	1.54	1.66	1.87	1.61	1.35	1.31	1.18	0.76	1.65	1.59	1.43	1.16	1.01
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		1.40	0.84	1.21	1.62	1.20	1.53	1.84	1.41	1.42	0.79	0.73	0.49	0.92	0.93	0.85	0.78	0.70
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	1.96	2.15	2.03	2.09	2.79	2.38	2.07	2.72	1.75	2.21	1.93	1.37	2.77	2.61	2.68	2.25	1.88
31	146	11	-8		0.33	0.21	0.22	0.31	0.24	0.22	0.38	0.30	0.21	0.16	0.11	0.06	0.29	0.22	0.18	0.20	0.13
32	148	11	-6		0.64	0.18	0.22	0.73	0.24	0.27	0.91	0.38	0.26	0.28	0.14	0.27	0.24	0.13	0.36	0.69	0.34
33	154	11	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	156	11	2	C11 PARAFFINS	0.66	0.49	0.43	1.31	1.15	0.90	1.15	1.01	0.61	0.78	0.43	0.32	0.68	0.40	0.67	0.56	0.30
36	156	12	-12	DIME NAPHTHALENES	1.03	2.08	1.15	1.15	2.74	1.39	1.14	2.67	1.04	2.78	2.40	1.70	2.97	2.75	2.68	2.49	2.11
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.18	0.11	0.11	0.21	0.14	0.13	0.29	0.20	0.15	0.08	0.07	0.04	0.19	0.18	0.13	0.17	0.13
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.27	0.14	0.22	0.16	0.10	0.13	0.25	0.15	0.17	0.17	0.14	0.10	0.15	0.13	0.13	0.16	0.13
42	170	12	2		0.23	0.14	0.11	0.26	0.19	0.13	0.27	0.20	0.11	0.06	0.07	0.05	0.10	0.13	0.13	0.08	0.10
43	170	13	-12	ALKYL NAPHTHALENES	0.60	1.41	0.67	0.32	1.44	0.63	0.65	1.81	0.61	1.71	1.32	0.88	2.04	1.68	1.61	1.90	1.41
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.11	0.46	0.43	0.16	0.77	0.67	0.18	0.86	0.58	0.66	0.43	0.38	0.83	0.58	0.71	0.65	0.40
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.16	0.11	0.11	0.37	0.29	0.27	0.31	0.25	0.18	0.25	0.21	0.20	0.15	0.13	0.18	0.12	0.10
51	184	13	2		0.42	0.11	0.00	0.16	0.05	0.00	0.16	0.05	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.03
52	184	14	-12		0.21	0.28	0.18	0.47	0.77	0.45	0.53	0.86	0.38	0.53	0.29	0.24	0.68	0.40	0.49	0.57	0.30
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.38	0.88	0.37	0.21	0.77	0.45	0.21	0.75	0.34	0.81	0.79	0.38	1.26	1.33	0.89	0.93	0.87
56	194	15	-16		0.03	0.07	0.05	0.05	0.14	0.09	0.05	0.15	0.07	0.00	0.00	0.00	0.15	0.13	0.09	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.14	0.11	0.09	0.26	0.24	0.18	0.22	0.20	0.12	0.04	0.07	0.03	0.15	0.27	0.13	0.06	0.10
59	198	14	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.17	0.21	0.14	0.26	0.38	0.22	0.24	0.35	0.16	0.29	0.11	0.13	0.34	0.13	0.22	0.39	0.13
61	202	16	-22	PYRENE	0.42	0.11	0.22	0.16	0.05	0.09	0.66	0.20	0.28	0.12	0.11	0.08	0.15	0.13	0.13	0.13	0.10
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.33	0.33	0.38	0.26	0.48	0.31	0.36	0.65	0.33	0.28	0.43	0.13	0.73	1.20	0.49	0.54	0.77
64	210	15	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.48	0.11	0.45	0.26	0.05	0.18	1.93	0.35	1.04	0.20	0.21	0.12	0.19	0.22	0.18	0.10	0.10
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.33	0.33	0.34	0.37	0.29	0.27	0.61	0.50	0.37	0.31	0.29	0.14	0.53	0.53	0.36	0.37	0.34
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.06	0.11	0.06	0.10	0.00	0.04	0.05	0.20	0.04	0.12	0.11	0.05	0.15	0.13	0.09	0.08	0.07
76	234	17	-18		0.04	0.11	0.04	0.05	0.00	0.04	0.03	0.20	0.02	0.06	0.04	0.03	0.15	0.09	0.09	0.12	0.07
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.14	0.00	0.13	0.26	0.00	0.09	0.12	0.15	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.04	0.00	0.04	0.10	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTAL:	44.92	34.65	36.19	50.43	46.84	44.32	53.65	49.14	36.31	41.82	35.11	26.28	47.83	43.28	44.16	41.13	[illegible]

Task 6. Hydrothermal Deactivation of Cracking Catalyst
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
-Blend A-

	Steamed									Thermal								
Deactivation Period	8 h			16 h			32 h			4 h			8 h			16 h		
Catalyst/Oil	3.7	4.0	3.8	4.0	3.6	3.8	4.1	3.8	4.2	3.6	4.2	4.5	3.6	4.0	3.6	3.8	4.2	4.0
Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S
File Reference	M674	M676	M675	M680	M681	M682	M677	M678	M679	M661	M658	M660	M666	M667	M669	M673	M671	M670
PARAFFINS																		
C1	0.57	0.75	0.70	0.49	0.55	0.57	0.40	0.56	0.71	0.55	0.82	1.02	0.55	0.62	0.70	0.69	0.68	0.97
C2	0.66	0.91	0.86	0.62	0.77	0.80	0.57	0.79	0.91	0.66	0.96	1.23	0.69	0.80	0.86	0.82	0.87	1.13
C3	3.23	4.36	3.95	2.70	3.27	3.49	2.26	2.99	3.92	4.37	5.37	8.06	3.40	3.87	4.60	5.07	4.72	5.98
C4	16.34	19.10	16.76	14.28	15.56	15.94	12.77	14.57	19.33	17.65	19.77	25.00	15.59	16.48	16.95	18.79	19.95	22.44
C5	11.98	14.93	12.56	10.69	11.39	12.28	10.24	10.61	14.08	12.96	13.20	15.55	11.00	11.96	10.53	11.15	15.21	14.82
C6	5.13	4.80	5.01	5.21	5.16	5.65	5.31	5.05	4.92	5.11	4.75	4.07	4.78	4.94	4.81	4.31	5.10	4.29
C7	4.64	3.57	3.90	5.36	4.74	5.00	5.39	4.73	4.19	4.28	3.60	2.79	4.61	4.22	4.18	4.33	3.64	3.07
C8	7.02	4.26	4.65	7.94	5.87	5.92	8.45	6.14	4.74	4.84	3.90	3.12	5.98	5.05	5.38	5.11	3.79	3.51
C9	3.10	1.79	2.00	3.61	2.55	2.56	3.84	2.67	2.12	1.92	1.50	1.06	2.48	2.08	2.05	2.17	1.64	1.32
C10	1.40	0.84	1.21	1.62	1.20	1.53	1.84	1.41	1.42	0.79	0.75	0.49	0.92	0.93	0.85	0.78	0.70	0.53
C11	0.66	0.49	0.43	1.31	1.15	0.90	1.15	1.01	0.61	0.78	0.43	0.52	0.68	0.40	0.67	0.56	0.30	0.42
C12	0.23	0.14	0.11	0.26	0.19	0.13	0.27	0.20	0.11	0.06	0.07	0.05	0.10	0.13	0.13	0.08	0.10	0.08
C13+	0.46	0.11	0.04	0.26	0.05	0.00	0.19	0.05	0.03	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.03	0.00
TOTAL	55.42	56.14	52.19	54.37	52.47	54.77	52.68	50.77	57.08	53.98	55.19	62.96	50.78	51.49	51.90	53.87	56.74	58.57
OLEFINS																		
C2	0.49	0.64	0.53	0.43	0.49	0.48	0.34	0.48	0.54	0.54	0.66	0.87	0.51	0.52	0.58	0.59	0.52	0.74
C3	6.13	6.12	5.23	6.01	5.78	5.25	5.73	5.94	6.54	4.72	4.78	4.28	5.39	4.67	4.57	4.35	4.81	5.05
C4	4.00	3.66	3.06	4.28	3.65	3.16	4.19	3.90	3.73	2.73	2.37	2.00	3.32	2.62	2.52	2.31	2.54	2.10
C5	0.68	0.73	0.59	1.05	0.93	0.82	0.84	0.85	0.73	0.88	0.72	0.77	0.68	0.58	0.69	0.60	0.67	0.73
C6	1.07	0.74	6.02	1.26	0.97	0.91	1.25	0.98	0.81	0.88	1.02	0.66	0.81	1.00	0.85	0.61	0.86	0.72
C7	1.33	0.95	0.95	1.57	1.35	1.21	1.41	1.21	0.82	0.83	0.89	0.67	0.97	1.15	1.25	0.78	0.84	0.75
C8	1.40	0.88	1.10	1.52	1.15	1.35	1.55	1.16	1.04	1.06	0.68	0.49	1.22	0.84	0.85	1.16	0.74	0.61
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	15.11	13.71	17.49	16.12	14.33	13.18	15.30	14.51	14.19	11.64	11.14	9.74	12.89	11.40	11.30	10.40	10.97	11.01
cycloOLEFINS																		
C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AROMATICS																		
C6	0.46	0.39	0.43	0.46	0.44	0.47	0.48	0.45	0.40	0.70	0.63	0.46	0.53	0.55	0.49	0.41	0.44	0.33
C7	1.14	0.81	1.13	1.05	0.91	1.17	1.02	0.91	0.92	0.95	0.89	0.68	1.07	1.11	1.16	1.03	1.02	0.86
C8	3.06	2.25	2.84	2.87	2.60	3.05	2.79	2.51	2.27	2.48	2.36	1.73	2.53	2.61	2.77	2.34	2.11	1.82
C9	2.96	2.25	2.56	3.45	3.13	3.23	3.39	3.07	2.47	3.26	2.36	1.90	3.40	2.61	2.95	3.15	2.18	2.05
C10	3.71	2.78	3.08	4.13	3.75	3.77	4.33	3.92	3.06	3.37	2.72	1.95	3.94	3.41	3.39	2.76	2.15	1.77
C11	2.93	2.53	2.47	3.14	3.27	2.87	3.35	3.32	2.22	2.65	2.18	1.70	3.31	2.97	3.21	3.14	2.35	2.49
C12	1.22	2.18	1.26	1.36	2.89	1.53	1.43	2.87	1.19	2.86	2.47	1.73	3.16	2.92	2.81	2.66	2.25	1.83
C13+	4.18	5.00	4.08	3.92	5.77	4.13	6.40	7.75	4.79	5.56	4.54	2.89	7.63	7.13	5.80	6.11	4.90	3.51
TOTAL	19.65	18.19	17.86	20.37	22.75	20.21	23.19	24.79	17.33	21.85	18.15	13.06	25.56	23.32	22.59	21.60	17.39	14.67

P E T R O - C A N A D A
Research & Development

X

Task 6, Hydrothermal Deactivation of Cracking Catalyst
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectroscopy
Blend 6

ENTRY	MASS	C #	Z #	COMPONENT	Steamed									Thermal								
				Deactivation Period	8 h			16 h			32 h			4 h			8 h			16 h		
				Catalyst/Oil	4.167	4.103	3.674	4.038	4.083	3.990	3.942	4.068	3.897	4.242	3.886	3.945	4.271	4.027	4.033	[illegible]	[illegible]	[illegible]
				Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S
				File Reference	M364	M363	M365	M369	M370	M371	M366	M367	M368	M628	M629	M630	M631	M649	[illegible]	M646	[illegible]	[illegible]
1	56	4	0		0.00	0.05	0.00	0.00	0.05	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.14	[illegible]
2	58	4	2	BUTANES	0.00	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	[illegible]
3	70	5	0		0.38	0.71	0.14	0.42	0.74	0.14	0.30	0.53	0.37	0.66	0.21	0.27	0.69	0.27	0.23	0.71	[illegible]	[illegible]
4	72	5	2	PENTANES	0.77	1.22	1.03	0.83	1.27	1.02	0.85	0.81	0.78	1.07	0.52	0.56	1.24	0.78	0.69	1.17	0.84	[illegible]
5	78	6	-6	BENZENE	0.86	0.51	0.94	0.94	0.53	0.95	0.35	0.43	0.41	0.62	0.52	0.68	0.85	0.89	[illegible]	0.58	[illegible]	[illegible]
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]
7	84	6	0		1.44	1.38	1.41	1.56	1.42	1.39	1.05	1.20	1.20	1.47	0.58	0.85	1.54	1.16	0.73	1.15	1.11	1.28
8	84	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	3.45	4.75	3.90	3.74	4.90	3.85	3.61	3.45	3.50	2.90	2.16	2.58	4.03	2.84	2.98	2.82	3.14	2.51
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	1.01	0.56	0.42	1.09	0.58	0.42	0.40	0.57	0.55	1.35	1.09	1.61	1.54	1.52	1.45	1.20	1.47	1.52
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	98	7	0		1.87	1.48	1.74	2.03	1.53	1.71	1.80	1.68	1.52	0.97	0.78	0.85	1.70	1.70	1.19	1.04	1.25	0.89
14	100	7	2	HEPTANES	4.36	4.75	4.27	4.73	4.90	4.22	4.11	3.83	3.63	2.34	2.05	2.41	3.65	4.06	3.06	3.19	2.82	2.16
15	106	8	-6	XYLENES	1.97	1.48	1.17	2.13	1.53	1.16	1.70	1.34	2.35	4.45	3.14	3.79	4.03	3.61	4.40	3.72	4.32	3.77
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		1.68	1.28	1.31	1.82	1.32	1.30	1.35	1.29	1.01	0.73	0.37	0.55	1.06	1.07	0.69	0.40	0.48	0.22
18	114	8	2	OCTANES	3.50	3.57	3.10	3.79	3.69	3.06	3.91	3.40	2.85	1.62	1.22	1.50	3.13	2.90	2.29	2.08	2.25	1.95
19	118	9	-8	INDANES	0.29	0.31	0.38	0.31	0.32	0.37	0.35	0.34	0.28	0.18	0.13	0.11	0.53	0.49	0.27	0.34	0.36	0.20
20	120	9	-6	C9 AB'S	1.68	1.89	1.97	1.82	1.95	1.95	2.36	1.63	2.02	3.94	2.93	3.97	4.61	4.33	3.94	3.53	3.32	3.94
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.14	0.10	0.14	0.16	0.11	0.14	0.05	0.10	0.14	0.04	0.00	0.03	0.05	0.00	0.00	0.04	0.00	0.04
23	128	9	2		3.21	2.45	1.93	3.48	2.33	1.90	3.16	2.68	3.59	1.14	0.91	0.45	1.96	1.92	0.61	0.75	0.88	0.29
24	128	10	-12	NAPHTHALENE	1.87	1.84	1.64	2.03	1.90	1.62	1.70	1.82	1.79	0.88	0.83	0.90	1.54	1.78	1.26	0.94	1.29	0.96
25	132	10	-8	INDANE	0.24	0.26	0.23	0.26	0.26	0.23	0.30	0.34	0.09	0.07	0.05	0.04	0.42	0.40	0.23	0.22	0.24	0.14
26	134	10	-6	C10 AB'S	1.10	1.12	1.08	1.20	1.16	1.07	1.35	1.24	1.06	2.37	1.64	1.86	3.28	2.90	2.22	2.24	2.37	1.83
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		2.35	1.68	1.46	2.55	1.74	1.44	2.31	1.87	2.07	0.14	0.10	0.17	0.42	0.40	0.42	0.17	0.20	0.21
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	2.59	3.27	2.72	2.81	3.37	2.69	2.81	3.21	2.94	2.34	1.69	2.53	2.86	2.39	2.48	2.38	2.53	[illegible]
31	146	11	-8		0.29	0.26	0.23	0.31	0.26	0.23	0.40	0.38	0.23	0.22	0.13	0.19	0.37	0.27	0.27	0.19	0.16	0.17
32	148	11	-6		0.38	0.66	0.80	0.42	0.69	0.79	1.05	0.81	1.01	0.14	0.10	0.23	0.42	0.40	0.57	0.23	0.28	0.41
33	154	11	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
35	156	11	2	C11 PARAFFINS	1.34	1.33	1.32	1.46	1.37	1.30	2.11	1.63	1.47	0.16	0.13	0.10	0.21	0.22	0.11	0.13	0.16	0.05
36	156	12	-12	DIME NAPHTHALENES	2.69	3.21	2.91	2.91	3.32	2.87	2.51	3.06	2.58	3.00	1.56	2.59	3.28	2.14	2.33	4.09	3.10	3.52
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.00	0.05	0.05	0.00	0.05	0.05	0.05	0.05	0.05	0.12	0.05	0.10	0.16	0.09	0.11	0.18	0.12	0.16
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.58	0.77	0.56	0.62	0.79	0.56	0.70	1.10	0.60	0.31	0.10	0.53	0.11	0.04	0.13	0.00	0.00	0.00
42	170	12	2		0.67	0.77	0.85	0.73	0.79	0.83	1.20	0.91	0.78	0.00	0.00	0.00	0.21	0.09	0.00	0.17	0.18	0.00
43	170	13	-12	ALKYL NAPHTHALENES	0.91	1.22	1.36	0.99	1.27	1.34	0.95	1.29	1.29	3.60	0.88	3.12	2.12	0.67	1.57	5.27	2.05	4.84
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.29	0.41	0.42	0.31	0.42	0.42	0.55	0.48	0.46	0.19	0.13	0.14	0.42	0.36	0.27	0.33	0.22	0.25
47	180	14	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	182	14	-16	ME-FLUOR.	0.34	0.36	0.28	0.36	0.37	0.28	0.35	0.43	0.32	0.00	0.00	0.00	0.16	0.18	0.11	0.06	0.06	0.05
51	184	13	2		0.24	0.20	0.19	0.26	0.21	0.19	0.28	0.29	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	184	14	-12		0.38	0.46	0.42	0.62	0.47	0.42	0.70	1.01	0.64	0.27	0.21	0.20	0.69	0.67	0.42	0.49	0.56	0.38
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.58	0.66	0.66	0.62	0.69	0.65	0.70	0.77	0.31	0.47	0.23	0.32	0.79	0.49	0.46	0.80	0.60	0.59
56	194	15	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.02	0.16	0.13	0.00	0.00	0.00	0.00
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.10	0.15	0.42	0.10	0.16	0.42	0.10	0.34	0.14	0.04	0.03	0.03	0.11	0.09	0.00	0.08	0.08	0.07
59	198	14	2		0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.18	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
60	198	15	-12		0.29	0.31	0.47	0.31	0.32	0.46	0.30	0.48	0.18	0.27	0.08	0.13	0.37	0.13	0.15	0.56	0.24	0.29
61	202	16	-22	PYRENE	0.14	0.15	0.14	0.16	0.16	0.14	0.15	0.14	0.14	0.03	0.03	0.02	0.11	0.13	0.08	0.05	0.08	0.05
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.48	0.71	0.61	0.52	0.74	0.60	0.65	0.62	0.46	0.47	0.18	0.28	0.64	0.31	0.23	0.83	0.48	0.37
64	210	15	0		0.43	0.26	0.61	0.47	0.26	0.60	0.50	0.19	0.60	0.44	0.08	0.27	0.58	0.13	0.31	0.73	0.20	0.47
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.19	0.36	0.33	0.21	0.37	0.32	0.38	0.29	0.18	0.00	0.00	0.00	0.11	0.13	0.08	0.08	0.12	0.07
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.29	0.41	0.42	0.31	0.42	0.42	0.30	0.38	0.23	0.11	0.05	0.05	0.37	0.27	0.15	0.28	0.20	0.14
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.10	0.15	0.14	0.10	0.16	0.14	0.15	0.14	0.09	0.00	0.00	0.00	0.05	0.04	0.04	0.08	0.08	0.07
76	234	17	-18		0.10	0.10	0.09	0.10	0.11	0.09	0.10	0.10	0.09	0.00	0.00	0.00	0.05	0.04	0.04	0.04	0.04	0.34
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.19	0.10	0.23	0.21	0.11	0.23	0.10	0.14	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	242	19	-28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.19	0.26	0.23	0.21	0.26	0.23	0.15	0.19	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	268	19	2	TMPB	0.05	0.05	0.14	0.05	0.05	0.14	0.05	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTAL:	46.28	48.17	44.99	50.16	49.77	44.30	48.42	47.16	45.18	39.13	25.53	35.98	51.01	43.90	37.50	42.56	39.16	36.77

Task 6. Hydrothermal Deactivation of Cracking Catalyst
ReacReactor Effluent Carbon Distribution
by
Hydrocarbon Type
-Blend B-

	Steamed									Thermal								
Deactivation Period	8 h			16 h			32 h			4 h			8 h			16 h		
Catalyst/Oil	4.167	4.103	3.674	4.038	4.083	3.990	3.942	4.068	3.897	4.242	3.886	3.945	4.271	4.027	4.033	4.310	4.008	3.948
Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S
File Reference	M364	M363	M365	M369	M370	M371	M366	M367	M368	M628	M629	M630	M631	M649	M633	M646	M647	M648
PARAFFINS																		
C1	0.29	0.39	0.40	0.29	0.42	0.48	0.27	0.42	0.46	0.45	0.75	0.76	0.47	0.57	0.70	0.46	0.64	0.66
C2	0.37	0.47	0.48	0.38	0.47	0.55	0.38	0.47	0.54	0.50	0.83	0.81	0.59	0.64	0.78	0.51	0.68	0.77
C3	2.18	3.40	2.84	2.10	2.78	3.15	1.80	2.60	2.97	4.09	7.18	6.01	4.73	4.36	6.24	3.80	5.52	6.24
C4	16.70	19.00	17.57	16.61	17.50	18.55	17.02	18.21	18.86	21.43	26.81	23.20	19.09	21.38	22.51	20.52	22.53	22.61
C5	15.09	13.82	15.31	13.66	13.26	14.80	14.33	13.92	14.41	15.02	17.68	13.69	9.14	12.54	13.43	13.82	13.11	12.36
C6	6.55	6.89	6.81	6.00	6.88	6.46	6.19	5.72	5.81	5.20	4.68	4.31	4.82	5.13	4.60	4.74	4.71	3.98
C7	5.48	5.36	5.26	5.55	-5.57	5.03	4.96	4.50	4.35	2.92	2.78	2.83	3.89	4.45	3.36	2.63	3.15	2.48
C8	3.50	3.57	3.10	3.79	3.69	3.06	3.91	3.40	2.85	1.62	1.22	1.50	3.13	2.90	2.29	2.08	2.25	1.90
C9	3.21	2.45	1.93	3.48	2.53	1.90	3.16	2.68	3.59	1.14	0.91	0.45	1.96	1.92	0.61	0.75	0.88	0.29
C10	2.35	1.68	1.46	2.55	1.74	1.44	2.31	1.87	2.07	0.14	0.10	0.17	0.42	0.40	0.42	0.17	0.20	0.21
C11	1.34	1.33	1.32	1.46	1.37	1.30	2.11	1.63	1.47	0.16	0.13	0.10	0.21	0.22	0.11	0.13	0.16	0.09
C12	0.67	0.77	0.85	0.73	0.79	0.83	1.20	0.91	0.78	0.00	0.00	0.00	0.21	0.09	0.00	0.17	0.08	0.00
C13+	0.29	0.26	0.33	0.31	0.26	0.32	0.40	0.38	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	58.03	59.38	57.64	56.91	57.26	57.87	58.03	56.70	58.67	52.66	63.08	53.83	48.66	54.60	55.05	49.78	53.93	51.60
OLEFINS																		
C2	0.27	0.39	0.32	0.30	0.44	0.42	0.25	0.41	0.42	0.58	0.88	0.80	0.66	0.71	0.74	0.60	0.81	0.82
C3	5.23	3.94	4.58	5.34	4.75	4.92	5.87	5.38	5.29	4.43	4.17	3.80	4.12	4.72	3.44	4.68	4.07	3.46
C4	2.95	2.01	2.60	3.19	2.52	2.61	3.78	2.89	2.82	1.98	1.37	1.34	1.57	1.88	1.49	1.94	1.54	1.16
C5	0.87	1.07	0.77	0.96	1.16	0.63	0.98	0.96	0.87	1.11	0.45	0.59	0.88	0.54	0.56	1.11	0.63	0.56
C6	1.81	1.58	1.75	1.83	1.66	1.65	1.35	1.44	1.43	1.72	1.19	1.06	1.54	1.39	0.96	1.52	1.22	0.85
C7	2.23	1.48	1.74	2.03	1.53	1.71	1.80	1.68	1.52	0.97	1.13	0.85	1.70	1.70	1.46	1.04	1.25	0.89
C8	1.68	1.28	1.31	1.82	1.32	1.30	1.35	1.29	1.01	0.73	0.57	0.55	1.06	1.07	0.69	0.40	0.48	0.32
C9	0.14	0.10	0.14	0.16	0.11	0.14	0.05	0.10	0.14	0.04	0.00	0.03	0.05	0.00	0.00	0.04	0.00	0.04
C10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13+	0.43	0.26	0.61	0.47	0.26	0.60	0.50	0.19	0.60	0.44	0.08	0.27	0.58	0.13	0.31	0.73	0.20	0.47
TOTAL	15.61	12.11	13.81	16.09	13.75	13.97	15.94	14.33	14.09	11.99	9.83	9.30	12.16	12.15	9.64	12.07	10.19	8.56
cycloOLEFINS																		
C5	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00
AROMATICS																		
C6	1.10	0.66	1.19	1.08	0.65	1.14	0.51	0.55	0.55	0.82	0.82	0.87	0.91	0.98	0.89	0.72	0.85	0.83
C7	1.08	0.36	0.49	1.09	0.58	0.42	0.40	0.57	0.55	1.42	1.20	1.66	1.54	1.52	1.50	1.30	1.49	1.58
C8	1.98	1.56	1.17	2.13	1.53	1.24	1.70	1.34	2.35	4.52	3.23	5.84	4.09	3.61	4.44	3.72	4.02	5.07
C9	1.97	2.19	2.35	2.13	2.27	2.32	2.71	1.96	2.30	4.12	3.06	4.08	5.14	4.82	4.20	3.87	4.18	3.74
C10	3.21	3.21	2.96	3.48	3.32	2.92	3.36	3.40	2.94	3.33	2.52	2.81	5.24	5.09	3.71	3.40	3.90	2.94
C11	3.26	4.18	3.76	3.53	4.32	3.71	4.26	4.40	4.19	2.70	1.92	2.95	3.65	3.26	3.33	2.82	2.98	3.13
C12	2.69	3.27	2.96	2.91	3.37	2.92	2.56	3.11	2.62	3.11	1.61	2.69	3.44	2.23	2.45	4.27	3.22	3.68
C13+	5.42	6.68	6.91	5.87	6.91	6.81	6.37	8.00	5.71	5.78	2.05	4.79	6.25	3.66	3.90	9.06	4.95	7.21
TOTAL	20.71	22.32	21.79	22.24	22.95	21.46	21.86	23.34	21.21	25.80	16.42	25.69	30.27	25.16	24.42	29.15	25.59	28.18

PETRO-CANADA
Research & Development

Task 6. Hydrothermal Deactivation of Cracking Catalyst
Reactor Effluent Liquid Compositional Analysis
Gas Chromatography - Low Resolution Mass Spectrometry
Blend C

					Steamed									Thermal								
				Deactivation Period	8 h			16 h			32 h			4 h			6 h			16 h		
				Catalyst/Oil	4.0	4.0	3.8	4.3	4.0	3.9	4.1	3.8	3.6	4.1	3.9	3.6	4.0	4.0	3.7	4.1	4.0	3.8
				Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S
				File Reference	M651	M635	M636	M637	M638	M639	M640	M641	M642	M624	M622	M623	M625	M626	M627	M650	M644	M645
ENTRY	MASS	C #	Z #	COMPONENT																		
1	56	4	0		0.00	0.05	0.05	0.00	0.05	0.05	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.05	0.05
2	58	4	2	BUTANES	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.05	0.18	0.00	0.05	0.18
3	70	5	0		0.29	0.37	0.27	0.28	0.32	0.26	0.23	0.29	0.22	0.12	0.14	0.24	0.19	0.28	0.36	0.15	0.32	0.36
4	72	5	2	PENTANES	1.05	1.16	1.38	0.94	0.96	1.24	1.20	1.32	1.57	0.70	0.60	0.74	0.70	0.75	0.72	0.85	1.18	1.78
5	78	6	-6	BENZENE	1.00	1.27	1.19	1.11	1.23	1.19	0.94	1.15	1.07	1.04	0.81	1.16	0.94	0.94	1.06	1.22	1.27	1.42
6	82	6	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	84	6	0		1.01	1.32	0.99	1.22	1.45	1.14	0.97	1.26	0.93	0.92	0.74	0.88	1.08	1.12	1.45	0.92	1.10	0.92
8	94	4	-4	S THIOPHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	86	6	2	HEXANES	3.11	3.95	3.42	3.72	4.28	3.88	3.23	4.01	3.40	2.97	2.33	3.20	3.10	3.00	3.15	3.76	4.05	3.87
10	88	4	0	S THIOCYCLOPENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	92	7	-6	TOLUENE	1.06	1.48	1.37	1.44	1.77	1.71	1.18	1.55	1.44	1.61	1.20	1.87	1.36	1.27	1.53	1.49	1.56	1.88
12	96	7	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	98	7	0		2.29	2.21	2.16	2.35	2.20	2.28	2.89	2.75	2.69	1.96	1.20	1.96	2.02	1.55	1.94	2.36	2.10	2.33
14	100	7	2	HEPTANES	3.89	4.38	3.90	4.49	4.55	4.29	4.17	4.41	3.96	3.27	2.40	2.81	3.90	3.51	3.33	4.96	4.28	4.49
15	106	8	-6	XYLENES	2.31	3.38	2.68	3.33	4.35	3.67	2.61	3.78	2.96	4.26	3.46	4.64	3.29	3.33	3.47	3.64	4.20	3.94
16	110	8	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	112	8	0		0.91	1.00	0.89	1.11	1.07	0.98	0.96	0.97	0.87	0.76	0.60	0.65	0.99	0.98	0.86	0.84	0.95	0.73
18	114	8	2	OCTANES	3.54	3.69	3.09	4.22	3.91	3.57	3.99	4.01	3.46	2.59	1.87	2.07	3.47	3.09	2.66	3.28	3.42	2.59
19	118	9	-8	INDANES	0.62	0.63	0.54	0.89	0.80	0.72	0.88	0.86	0.72	0.49	0.42	0.47	0.61	0.66	0.59	0.52	0.63	0.51
20	120	9	-6	C9 AB'S	3.04	4.06	3.27	4.05	4.77	3.98	3.35	4.18	3.34	3.55	2.79	3.23	3.80	3.84	3.60	3.49	3.99	3.30
21	124	9	-2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	126	9	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	128	9	2		3.37	1.90	2.41	2.77	1.39	1.86	4.01	2.12	2.74	0.83	0.67	0.48	1.83	1.87	1.04	1.45	1.68	0.82
24	128	10	-12	NAPHTHALENE	2.62	2.58	2.58	2.66	2.36	2.53	3.07	2.87	2.93	1.38	0.95	1.51	1.97	1.73	2.16	2.31	2.31	2.55
25	132	10	-8	INDANE	0.99	0.74	0.77	0.94	0.64	0.72	1.17	0.86	0.90	0.35	0.32	0.34	0.61	0.70	0.59	0.49	0.63	0.46
26	134	10	-6	C10 AB'S	2.85	2.74	2.41	3.27	2.78	2.64	3.34	3.09	2.83	2.33	1.70	1.75	2.72	2.48	2.03	2.29	2.47	1.78
27	140	10	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	142	10	2		0.95	0.69	0.63	0.89	0.59	0.57	0.89	0.63	0.57	0.43	0.49	0.24	0.42	0.61	0.23	0.34	0.58	0.16
29	142	10	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	142	11	-12	ME NAPHTHALENES	3.27	3.64	3.41	3.49	3.43	3.41	3.59	3.72	3.50	3.14	2.58	3.30	3.10	3.19	3.29	2.84	3.42	3.01
31	146	11	-8		0.21	0.32	0.25	0.28	0.37	0.31	0.31	0.46	0.36	0.61	0.28	0.35	0.33	0.19	0.18	0.33	0.21	0.18
32	148	11	-6		0.35	0.32	0.29	0.44	0.37	0.36	0.43	0.40	0.36	0.66	0.42	0.46	0.47	0.37	0.32	0.34	0.32	0.22
33	154	11	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	154	12	-14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	156	11	2	C11 PARAFFINS	0.76	0.53	0.59	0.67	0.43	0.52	0.90	0.63	0.71	0.45	0.25	0.20	0.61	0.42	0.27	0.73	0.58	0.33
36	156	12	-12	DIME NAPHTHALENES	2.46	2.74	2.36	2.88	2.84	2.64	2.78	2.98	2.69	3.01	2.79	3.29	2.63	3.05	2.84	2.40	3.15	2.54
37	160	12	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	162	12	-6		0.39	0.21	0.39	0.22	0.11	0.21	0.33	0.17	0.31	0.11	0.07	0.06	0.23	0.19	0.14	0.17	0.16	0.10
39	166	13	-16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	168	12	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	168	13	-14	BIPHENYLS/CYCLODIAROM.	0.15	0.16	0.10	0.17	0.16	0.10	0.16	0.17	0.10	0.04	0.07	0.07	0.14	0.33	0.27	0.06	0.16	0.11
42	170	12	2		0.07	0.11	0.06	0.11	0.16	0.10	0.08	0.11	0.07	0.18	0.11	0.13	0.19	0.14	0.14	0.18	0.16	0.13
43	170	13	-12	ALKYL NAPHTHALENES	1.69	1.27	1.73	1.22	0.80	1.14	1.91	1.38	1.86	1.11	1.31	1.54	0.99	1.45	1.35	0.78	1.31	1.10
44	174	13	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	176	13	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	178	14	-18	PHENANTHRENE	0.70	0.63	0.68	0.78	0.64	0.72	0.92	0.80	0.87	0.57	0.46	0.41	0.70	0.78	0.50	0.54	0.63	0.38
47	180	14	-16		0.81	0.21	0.98	0.22	0.05	0.26	0.88	0.23	1.07	0.20	0.11	0.27	0.14	0.09	0.18	0.21	0.16	0.25
48	182	13	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	182	14	-14		0.48	0.37	0.67	0.39	0.27	0.32	0.93	0.69	1.22	0.38	0.25	0.37	0.23	0.19	0.23	0.33	0.32	0.33
50	182	14	-16	ME-FLUOR.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	184	13	2		0.05	0.00	0.05	0.00	0.00	0.05	0.06	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	184	14	-12		1.01	0.58	1.00	0.61	0.32	0.62	1.18	0.69	1.25	0.45	0.57	0.65	0.47	0.75	0.60	0.46	0.84	0.66
53	188	14	-8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	190	14	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	192	15	-18	ME PHENANTHR	0.69	0.69	1.00	0.55	0.48	0.72	0.60	0.57	0.83	0.78	0.67	1.27	0.52	0.56	0.86	0.55	0.68	0.91
56	194	15	-16		0.26	0.21	0.20	0.22	0.16	0.16	0.29	0.23	0.21	0.20	0.11	0.20	0.14	0.09	0.14	0.21	0.16	0.20
57	196	14	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
58	196	15	-14		0.48	0.21	0.39	0.28	0.11	0.21	0.83	0.34	0.63	0.18	0.14	0.18	0.14	0.14	0.14	0.14	0.16	0.14
59	198	14	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	198	15	-12		0.49	0.21	0.39	0.28	0.11	0.21	0.67	0.29	0.51	0.44	0.18	0.34	0.28	0.14	0.23	0.63	0.37	0.52
61	202	16	-22	PYRENE	0.22	0.16	0.22	0.17	0.11	0.16	0.33	0.23	0.32	0.13	0.11	0.13	0.14	0.14	0.14	0.09	0.11	0.09
62	204	15	-6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	206	16	-18	DIME PHEN.	0.43	0.47	0.47	0.44	0.43	0.47	0.45	0.46	0.48	0.49	0.39	0.63	0.38	0.37	0.50	0.36	0.42	0.50
64	210	15	0		0.07	0.05	0.07	0.11	0.00	0.05	0.00	0.00	0.00	0.31	0.18	0.35	0.33	0.23	0.36	0.33	0.26	0.34
65	212	15	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	212	16	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	216	16	-22	ME PYRENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
68	216	17	-22	ME PYRENE	0.16	0.21	0.16	0.22	0.27	0.21	0.18	0.23	0.17	0.08	0.11	0.08	0.14	0.23	0.14	0.05	0.11	0.05
69	220	16	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	220	17	-18		0.26	0.32	0.19	0.44	0.48	0.31	0.35	0.40	0.24	0.30	0.21	0.22	0.38	0.33	0.27	0.22	0.21	0.15
71	224	16	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	226	16	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	228	18	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	230	17	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	230	18	-22		0.07	0.11	0.07	0.11	0.16	0.10	0.08	0.11	0.07	0.03	0.04	0.03	0.09	0.14	0.09	0.03	0.05	0.03
76	234	17	-18		0.13	0.11	0.10	0.17	0.11	0.10	0.17	0.11	0.10	0.13	0.07	0.09	0.14	0.09	0.09	0.07	0.05	0.04
77	234	18	-18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	240	17	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	240	18	-12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	242	19	-24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	242	19	-20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	244	19	-22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	246	18	-6	TRIBUTYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	252	18	0	OCTADECENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	254	18	2	OCTADECANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	254	AND	OTHER	UN-ID. SATURATES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	268	19	2	TMPB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	310	22	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	324	23	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	352	25	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	366	26	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				TOTAL:	50.61	51.66	49.91	54.41	52.11	51.01	57.61	55.70	54.76	43.56	34.18	42.85	45.92	45.32	42.89	45.64	56.37	44.19

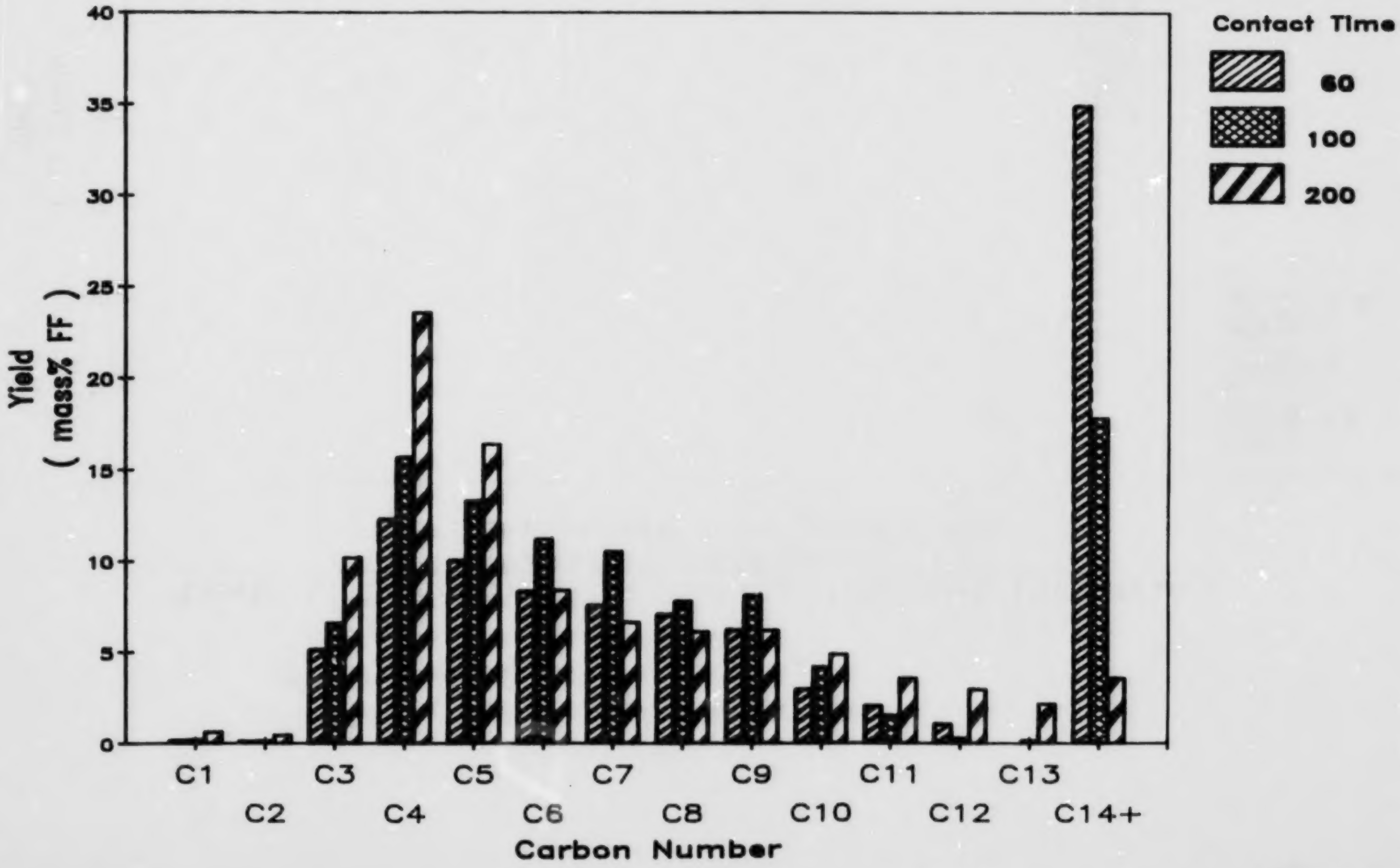
Task 6. Hydrothermal Deactivation of Cracking Catalyst
Reactor Effluent Carbon Distribution
by
Hydrocarbon Type
-Blend C-

	Steamed									Thermal								
Deactivation Period	8 h			16 h			32 h			4 h			8 h			16 h		
Catalyst/Oil	4.0	4.0	3.8	4.3	4.0	3.9	4.1	3.8	3.6	4.1	3.9	3.6	4.0	4.0	3.7	4.1	4.0	3.8
Injection Time	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S	60 S	120 S	200 S
File Reference	M651	M635	M636	M637	M638	M639	M640	M641	M642	M624	M622	M623	M625	M626	M627	M650	M644	M645
PARAFFINS																		
C1	0.31	0.45	0.51	0.31	0.44	0.45	0.28	0.36	0.46	0.50	0.67	0.68	0.40	0.46	0.36	0.43	0.43	0.60
C2	0.38	0.55	0.61	0.40	0.54	0.78	0.36	0.46	0.58	0.57	0.81	0.78	0.50	0.56	0.71	0.55	0.50	0.70
C3	3.04	3.95	4.22	2.61	3.55	3.76	2.30	2.80	3.46	4.09	5.77	5.71	3.42	3.77	4.84	3.95	3.43	4.83
C4	17.31	17.69	17.92	16.04	17.05	16.60	15.02	16.05	16.79	19.08	23.00	20.14	18.15	18.17	19.50	18.22	15.78	18.66
C5	12.69	10.85	11.33	11.34	12.05	9.21	10.66	10.70	10.28	13.14	14.98	11.64	13.85	13.52	12.90	13.14	11.76	12.51
C6	5.03	5.14	4.76	5.18	5.93	4.95	4.62	5.28	4.50	4.78	4.54	4.48	5.26	5.22	5.05	5.63	5.08	5.46
C7	4.31	4.74	4.27	4.93	5.03	4.30	4.66	4.88	4.27	3.76	2.96	3.19	4.44	4.14	3.69	4.63	4.71	3.90
C8	3.34	3.69	3.09	4.22	3.91	3.57	3.99	4.01	3.46	2.59	1.87	2.07	3.47	3.09	2.66	3.28	3.42	2.59
C9	3.37	1.90	2.41	2.77	1.39	1.86	4.01	2.12	2.74	0.83	0.67	0.48	1.83	1.87	1.04	1.45	1.68	0.82
C10	0.95	0.69	0.63	0.89	0.59	0.37	0.89	0.63	0.57	0.43	0.49	0.24	0.42	0.61	0.23	0.34	0.58	0.18
C11	0.76	0.53	0.59	0.67	0.43	0.52	0.90	0.63	0.71	0.45	0.25	0.20	0.61	0.42	0.27	0.73	0.58	0.33
C12	0.07	0.11	0.06	0.11	0.16	0.10	0.08	0.11	0.07	0.18	0.11	0.13	0.19	0.14	0.14	0.18	0.16	0.13
C13+	0.05	0.00	0.05	0.00	0.00	0.05	0.06	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	51.83	50.25	50.45	49.47	51.06	46.72	47.82	48.03	47.94	50.40	56.11	49.75	52.55	51.98	51.58	52.54	48.90	50.71
OLEFINS																		
C2	0.48	0.63	0.60	0.48	0.54	0.45	0.40	0.47	0.56	0.70	0.79	0.78	0.50	0.52	0.62	0.60	0.49	0.62
C3	4.76	3.90	3.71	4.61	3.87	3.25	4.45	4.44	4.34	4.48	4.24	3.51	4.64	4.18	3.80	4.21	3.34	3.31
C4	2.57	1.59	1.51	2.29	1.52	2.72	2.38	2.11	1.81	1.69	1.48	1.24	2.19	1.97	1.58	1.45	1.48	1.35
C5	0.70	0.60	0.51	0.60	0.60	0.26	0.58	0.55	0.45	0.49	0.53	0.52	0.61	0.68	0.66	0.54	0.64	0.68
C6	1.22	1.60	1.22	1.59	1.75	1.14	1.28	1.55	1.13	1.39	1.17	1.06	1.46	1.35	1.26	1.53	1.37	1.12
C7	2.29	2.21	2.16	2.55	2.20	6.37	2.89	2.75	2.69	1.96	1.20	1.96	2.02	1.55	1.94	2.36	2.10	2.33
C8	0.91	1.00	0.89	1.11	1.07	0.98	0.96	0.97	0.87	0.76	0.60	0.65	0.99	0.98	0.86	0.84	0.95	0.73
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13+	0.07	0.05	0.07	0.11	0.00	0.05	0.08	0.06	0.08	0.31	0.18	0.35	0.33	0.23	0.36	0.33	0.26	0.34
TOTAL	13.00	11.59	10.67	13.35	11.55	15.22	13.02	12.90	11.92	11.78	10.18	10.05	12.94	11.47	11.08	11.85	10.63	10.49
cycloOLEFINS																		
C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AROMATICS																		
C6	1.17	1.41	1.38	1.26	1.43	1.25	1.10	1.30	1.19	1.25	1.16	1.33	1.14	1.23	1.28	1.46	1.62	1.73
C7	1.06	1.48	1.42	1.44	1.77	1.71	1.18	1.55	1.44	1.61	1.30	1.94	1.36	1.32	1.53	1.49	1.63	1.73
C8	2.31	3.58	2.68	3.33	4.62	3.67	2.66	3.85	2.96	4.34	3.46	4.64	3.29	3.33	3.47	3.64	4.20	3.94
C9	3.66	4.69	3.82	4.94	5.57	4.71	4.23	5.04	4.06	4.05	3.22	3.69	4.41	4.50	4.19	4.01	4.62	3.81
C10	6.45	6.06	5.76	6.88	5.78	5.90	7.58	6.82	6.66	4.06	2.97	3.60	5.31	4.92	4.78	5.09	5.41	4.80
C11	3.83	4.27	3.95	4.22	4.18	4.09	4.33	4.58	4.23	4.42	3.29	4.11	3.90	3.75	3.79	3.51	3.94	3.42
C12	2.85	2.95	2.75	3.11	2.95	2.85	3.11	3.15	3.00	3.13	2.86	3.35	2.86	3.23	2.97	2.57	3.31	2.64
C13+	8.05	5.90	8.40	6.27	4.66	6.00	9.93	6.93	9.94	5.51	4.77	6.49	5.02	5.76	5.77	4.72	5.73	5.47
TOTAL	29.38	30.35	30.16	31.43	30.95	30.17	34.12	33.23	33.47	28.35	23.03	29.15	27.29	28.05	27.78	26.49	30.47	27.54

APPENDIX II

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane   Rx. Temp : 450 C

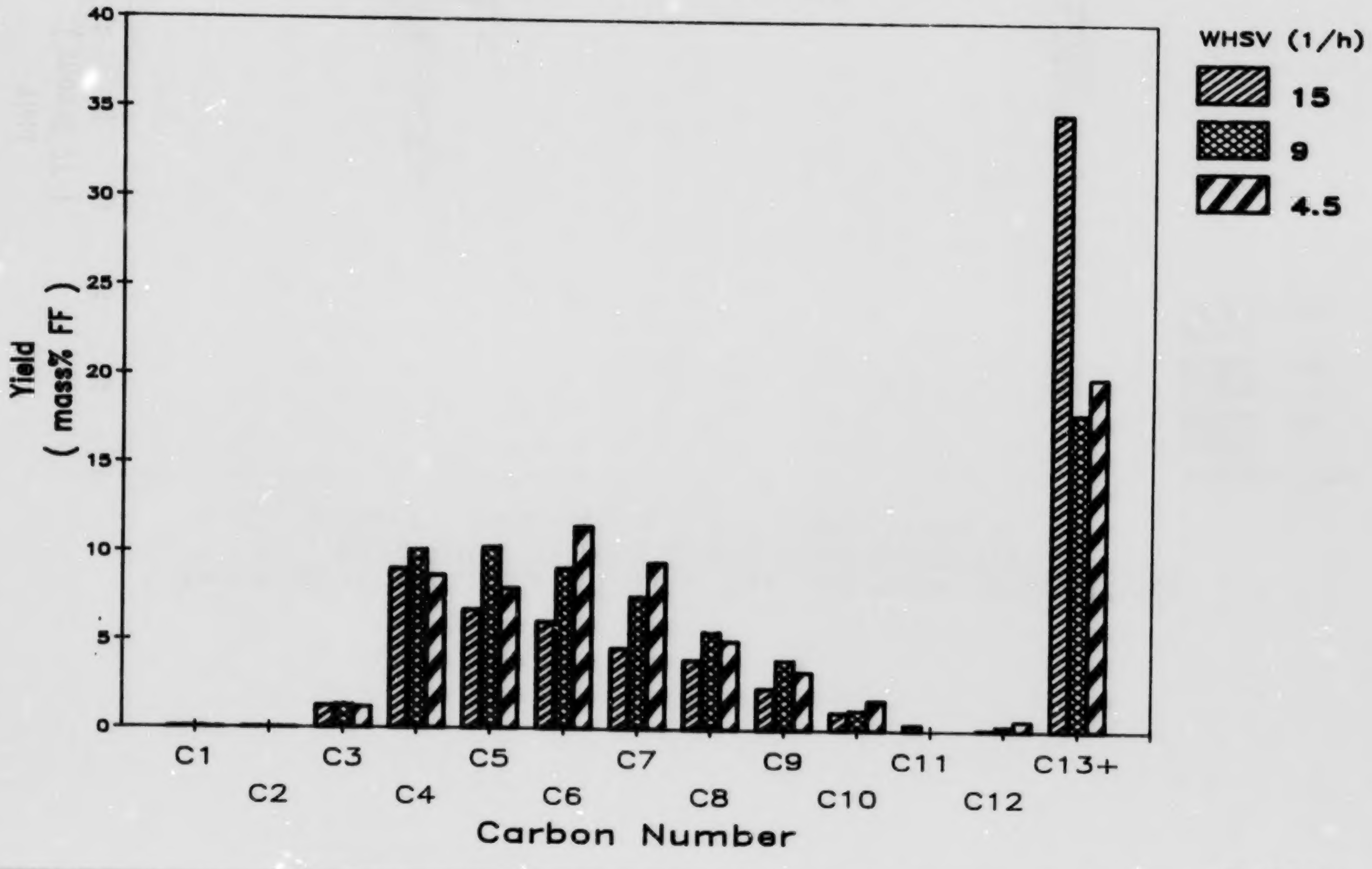


C1845CD

Task 1. Cracking Yields for Normal Paraffins

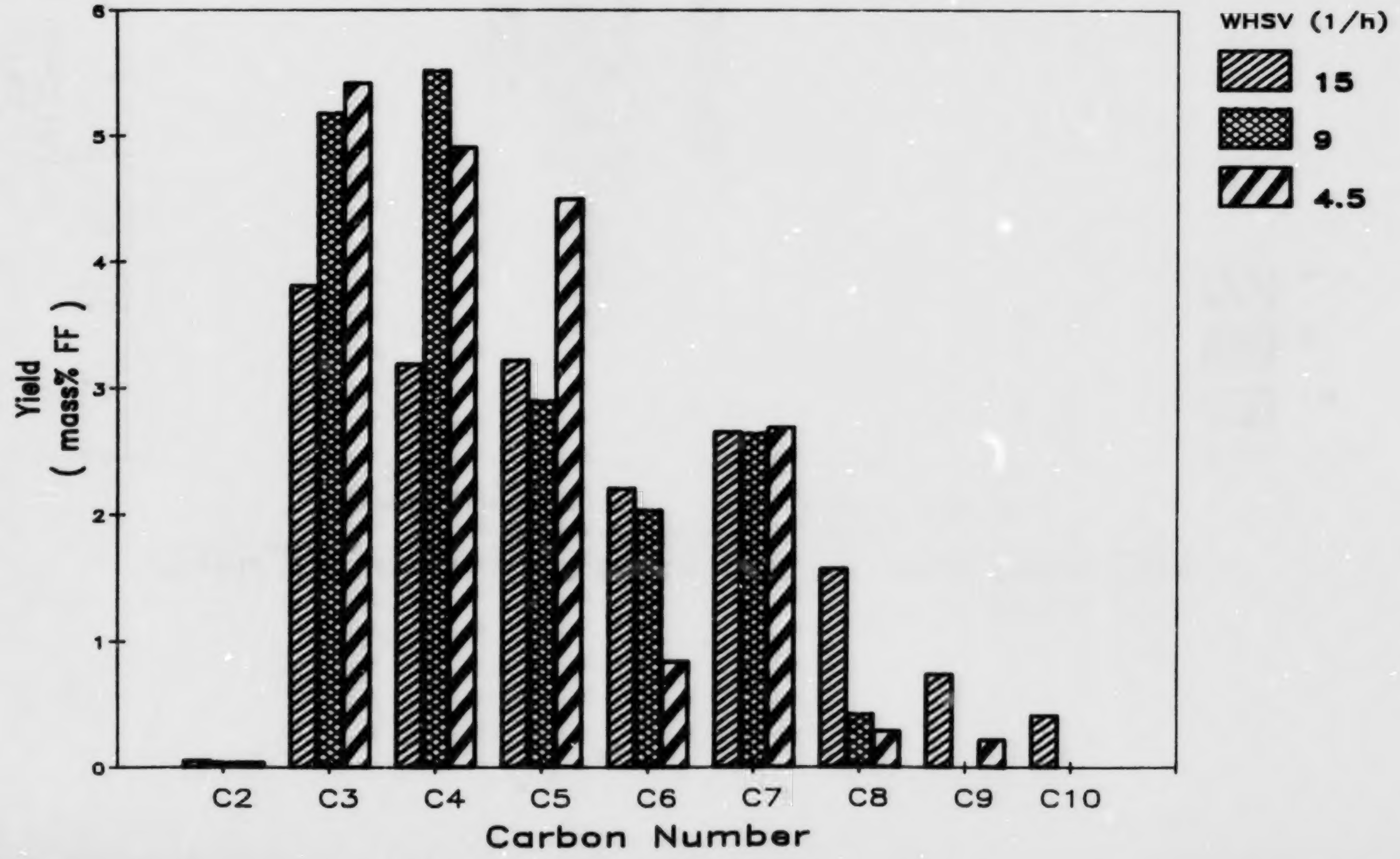
PARAFFIN DISTRIBUTION

Feed : Octadecane RX. TEMP : 450 C



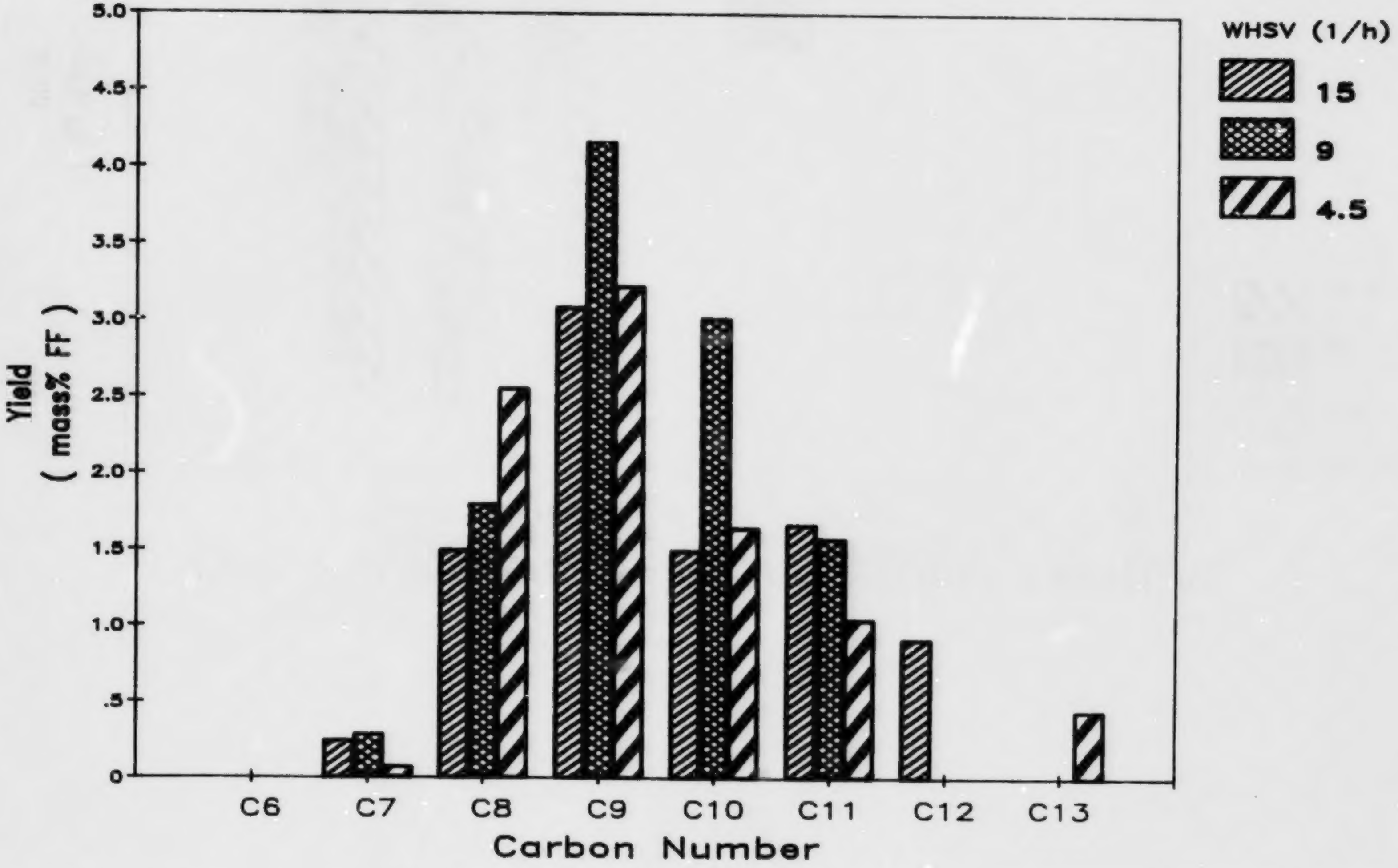
Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Octadecane   RX. TEMP : 450 C



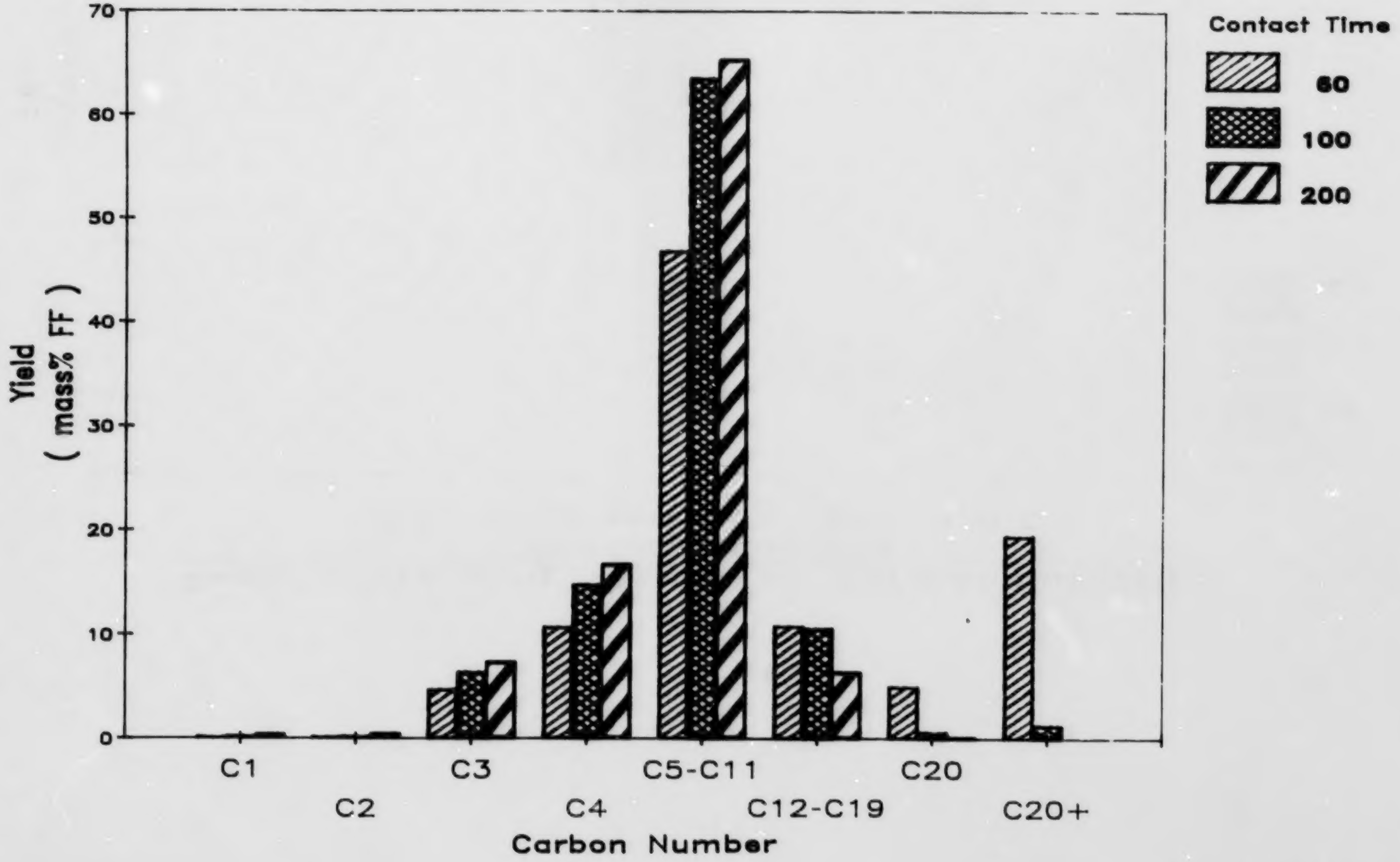
Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION
Feed : Octadecane   RX. TEMP : 450 C



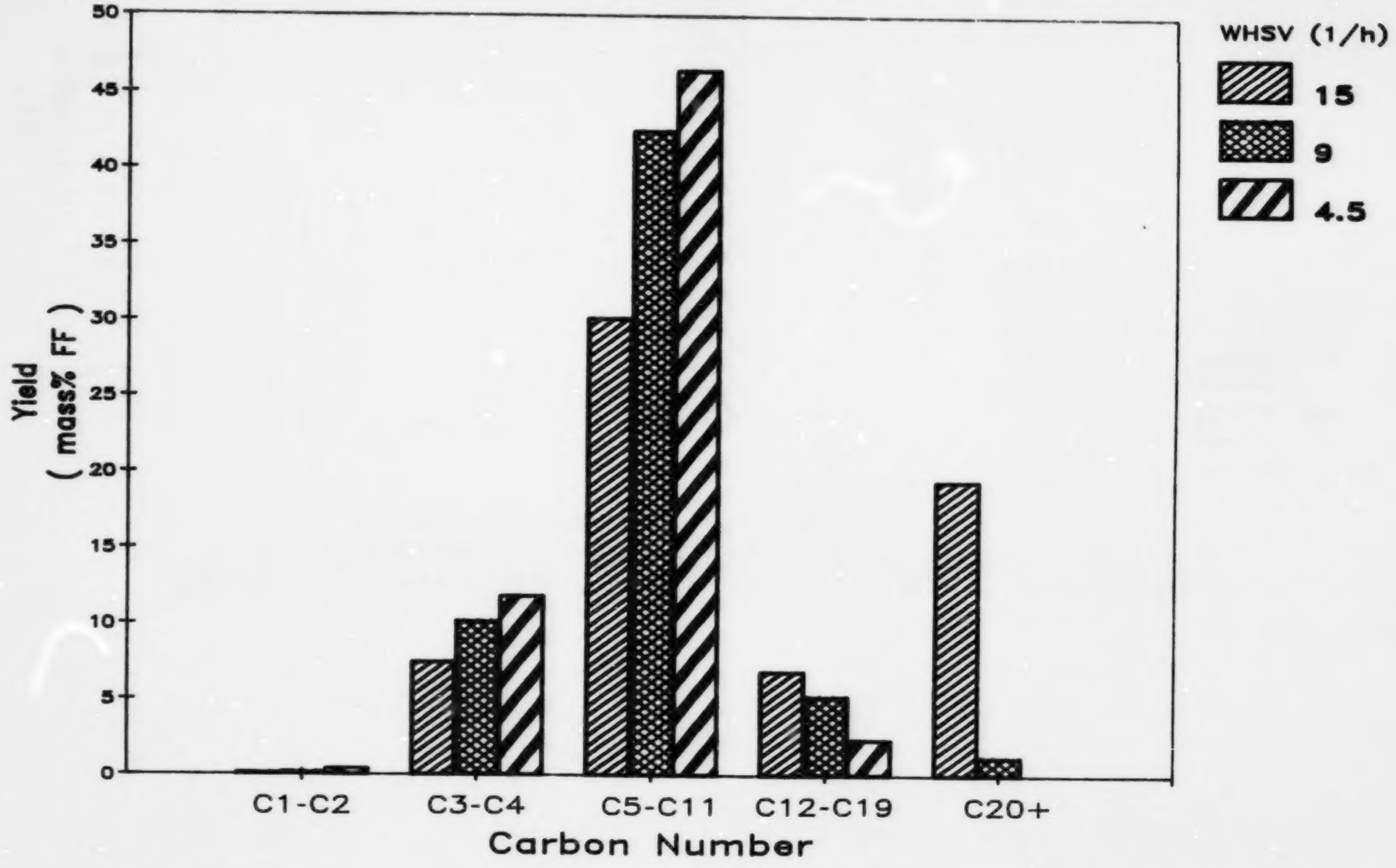
Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexacosane Rx. Temp : 450 C



C2645CD

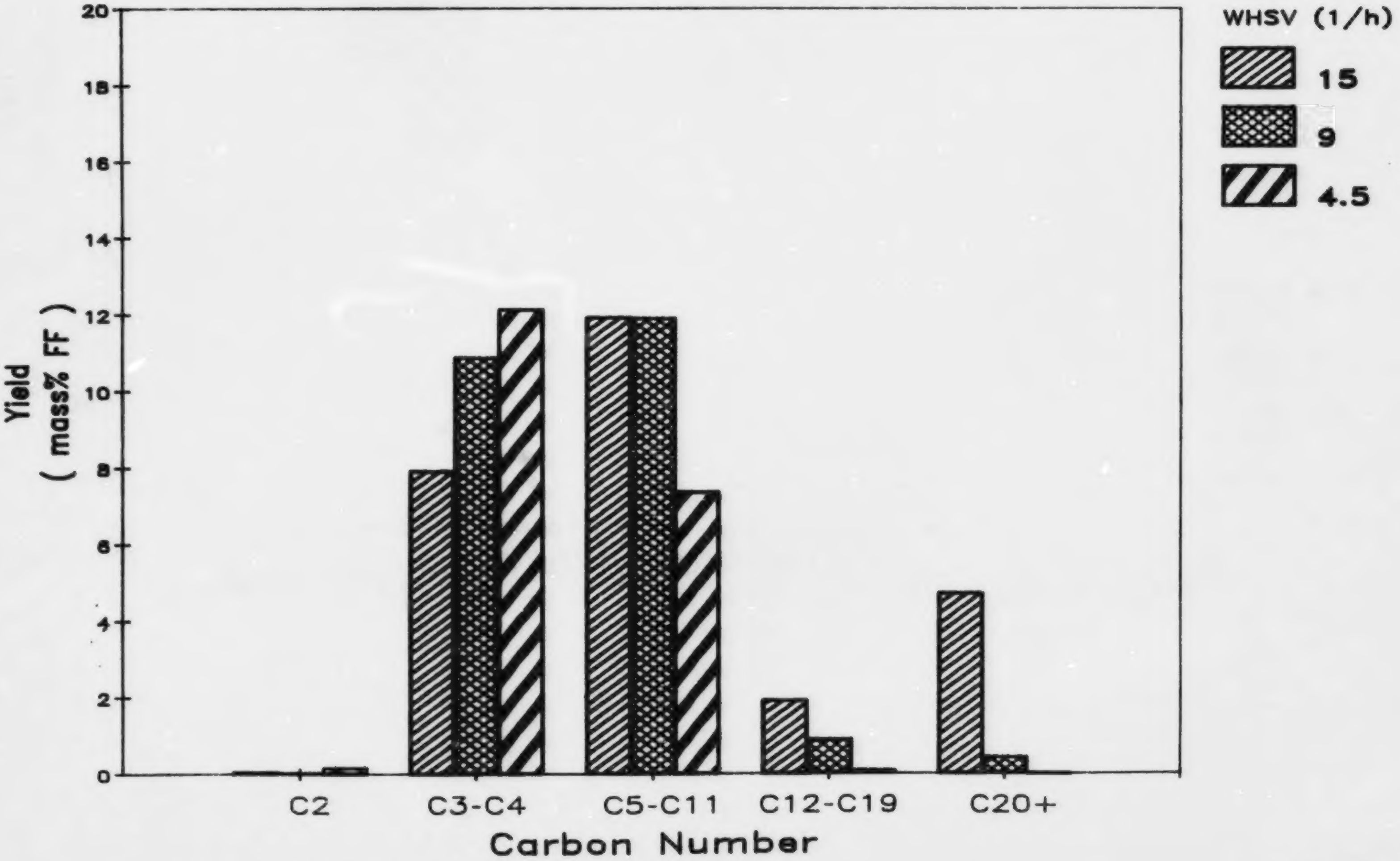
Task 1. Cracking Yields for Normal Paraffins



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Hexacosane   RX. TEMP : 450 C

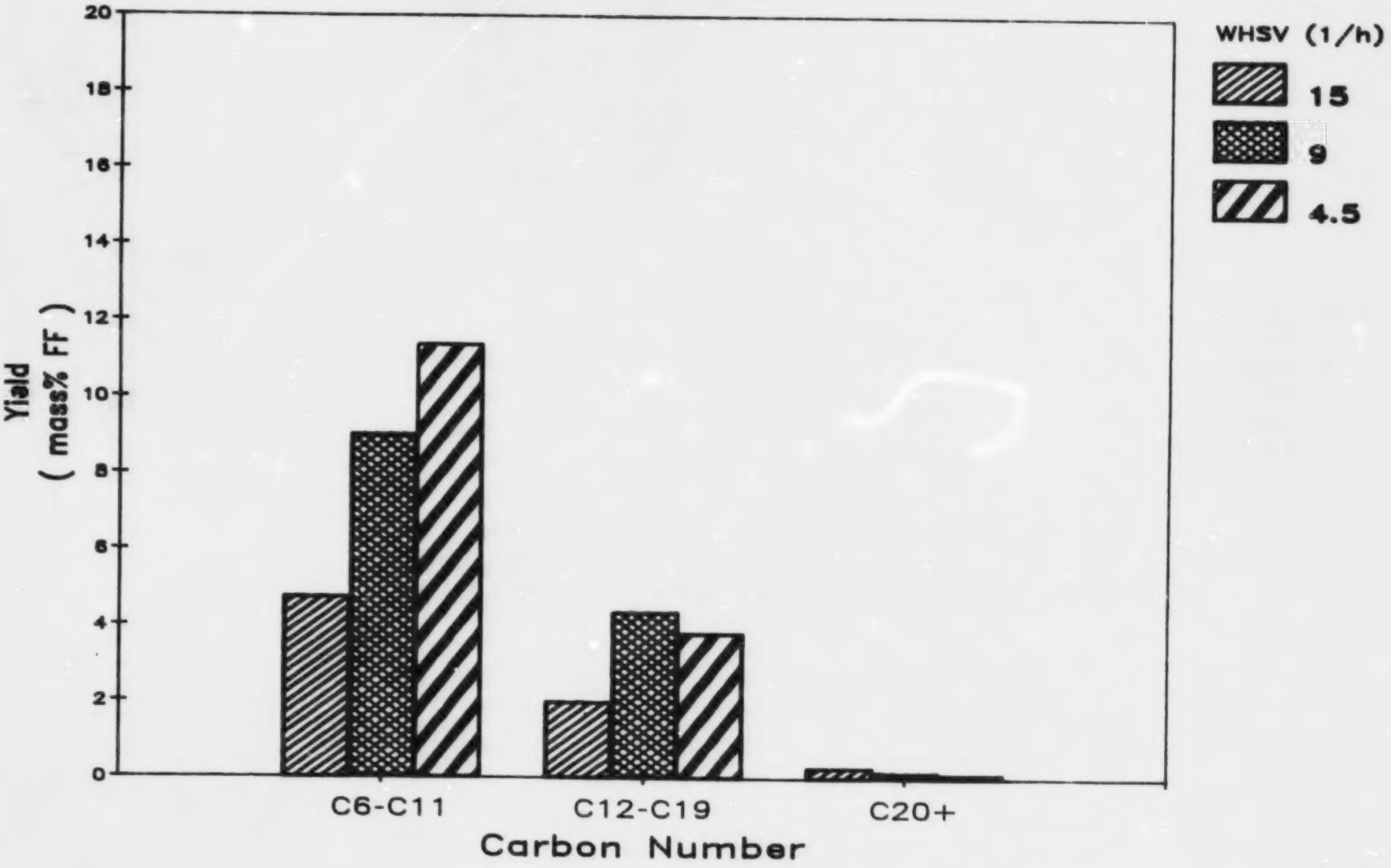


T1450C26

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Hexacosane   RX. TEMP : 450 C

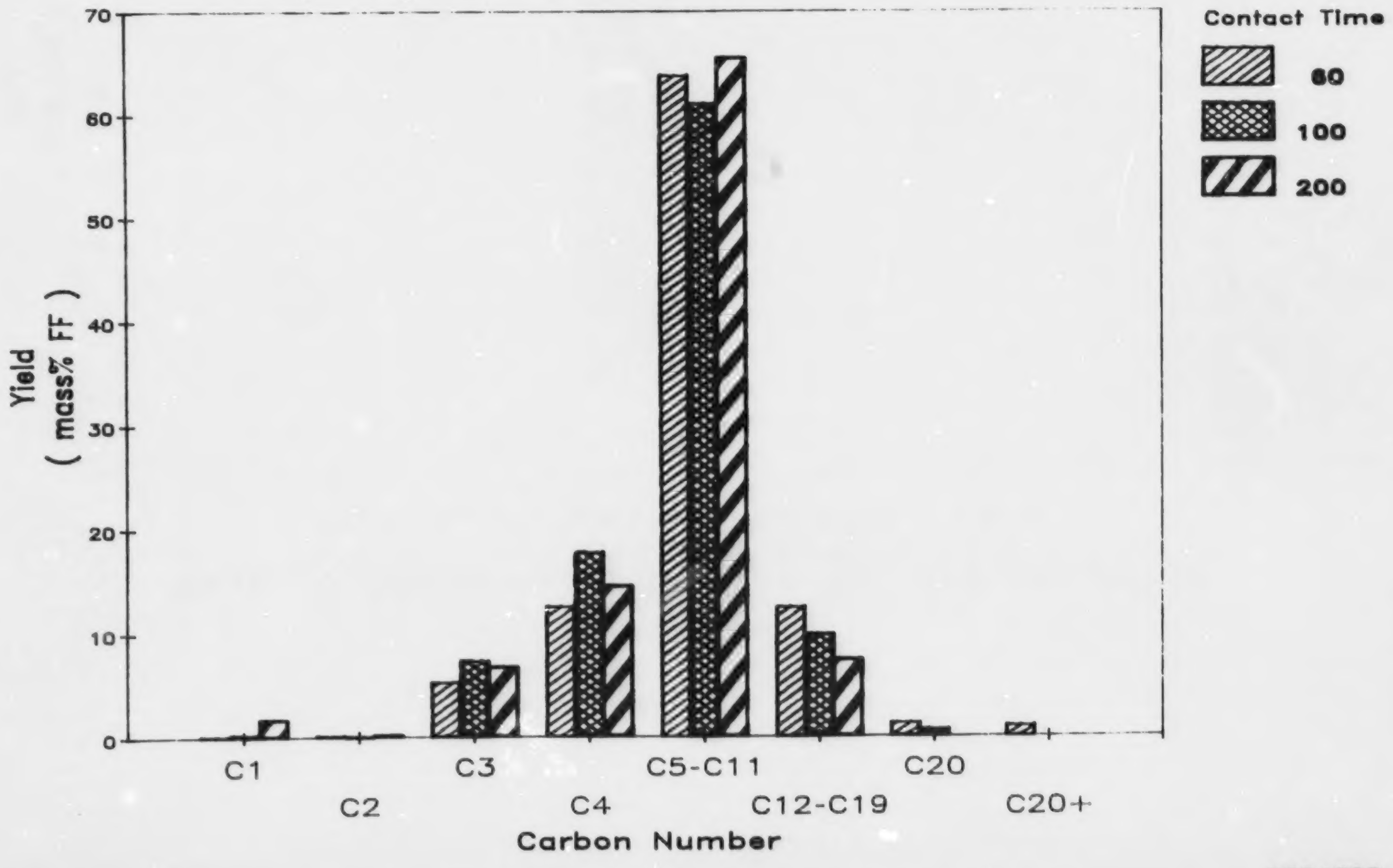


T145AC26

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION

Feed : Dotriacontane Rx. Temp 450 C



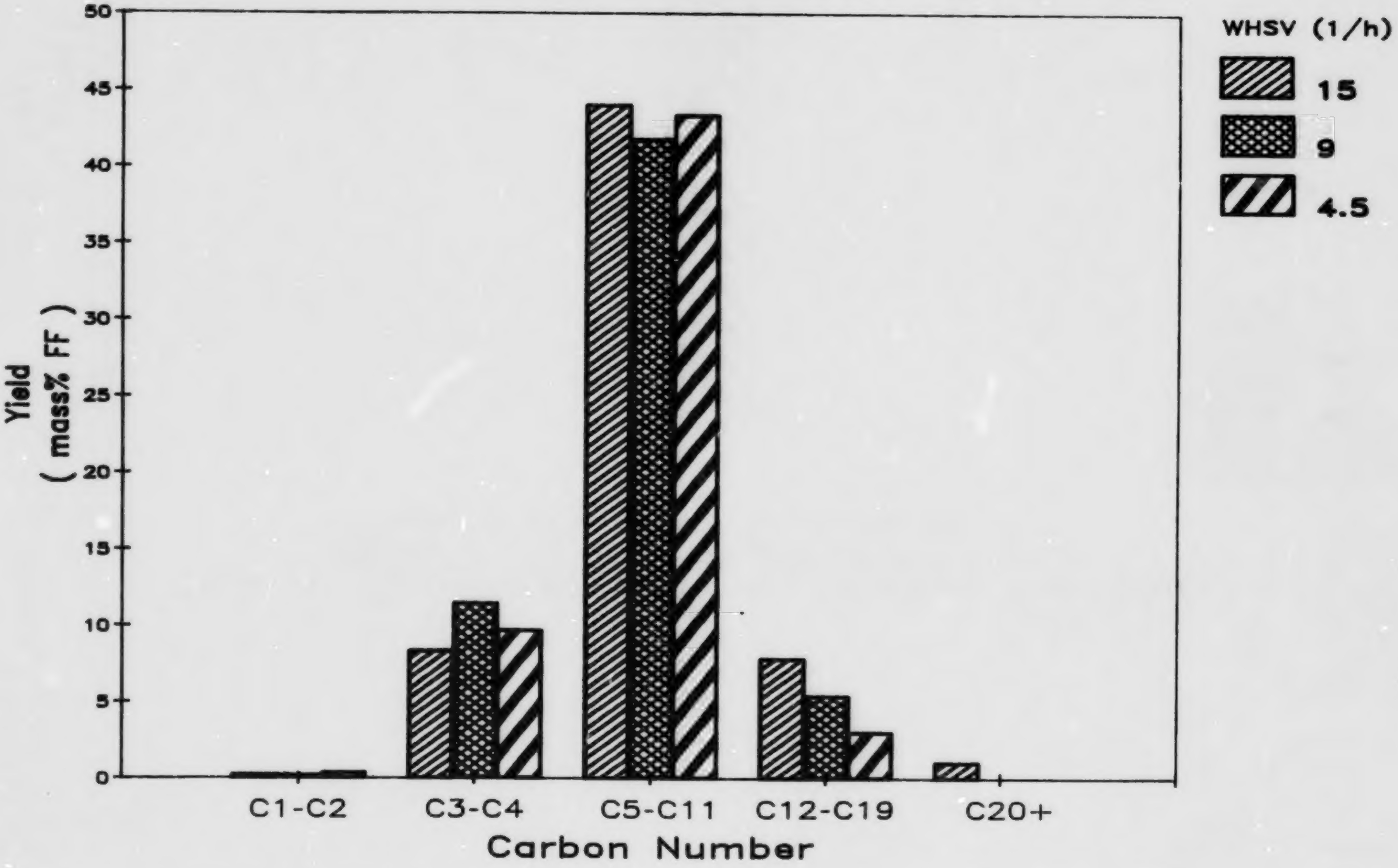
X

C3245CD

Task 1. Cracking Yields for Normal Paraffins

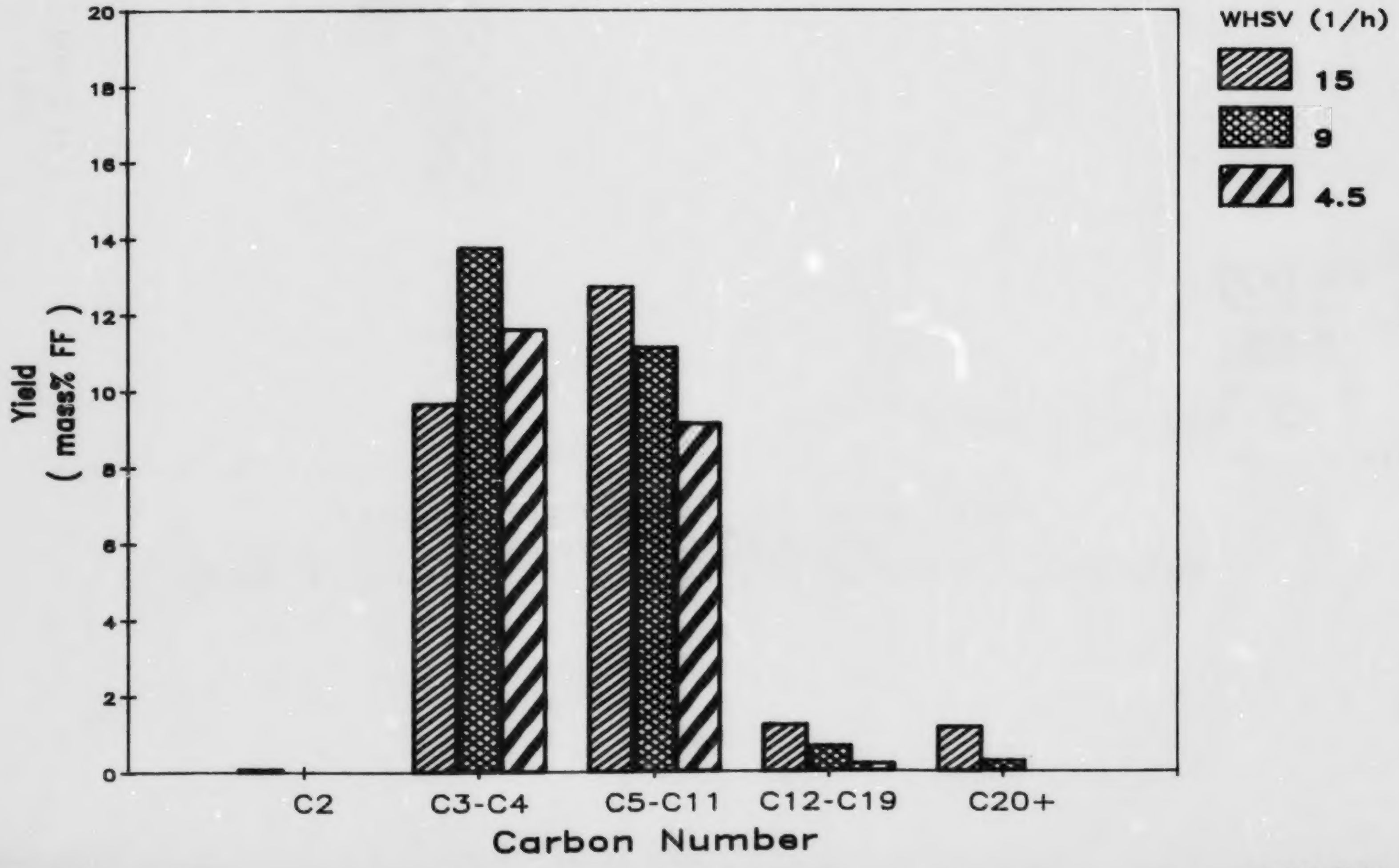
PARAFFIN DISTRIBUTION

Feed : Dotriacontane RX. TEMP : 450 C



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Dotriacontane   RX. TEMP : 450 C

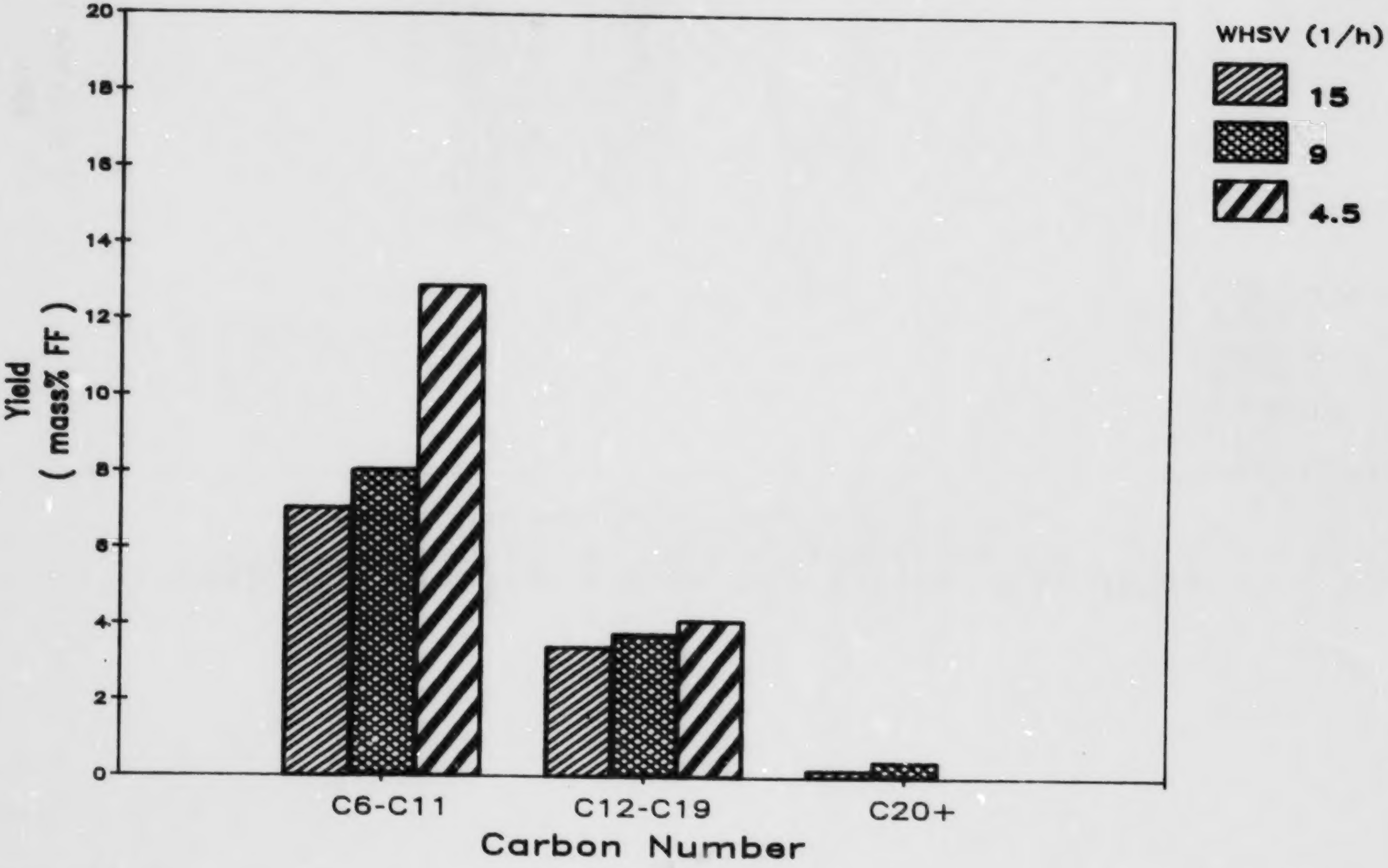


T1450C32

Task 1. Cracking Yields for Normal Paraffins

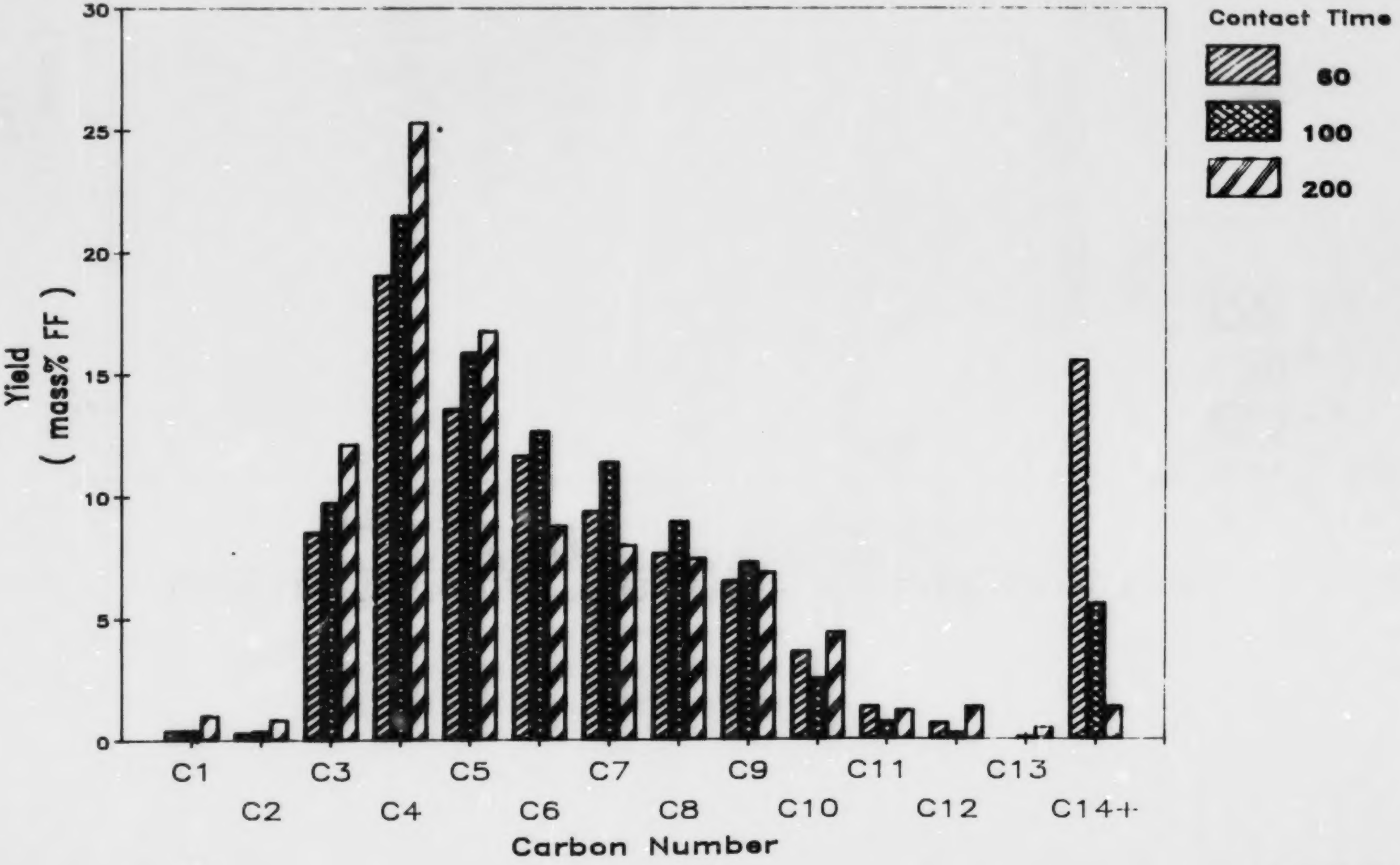
AROMATIC DISTRIBUTION

Feed : Dotriacontane RX. TEMP : 450 C



Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane Rx. Temp : 475 C

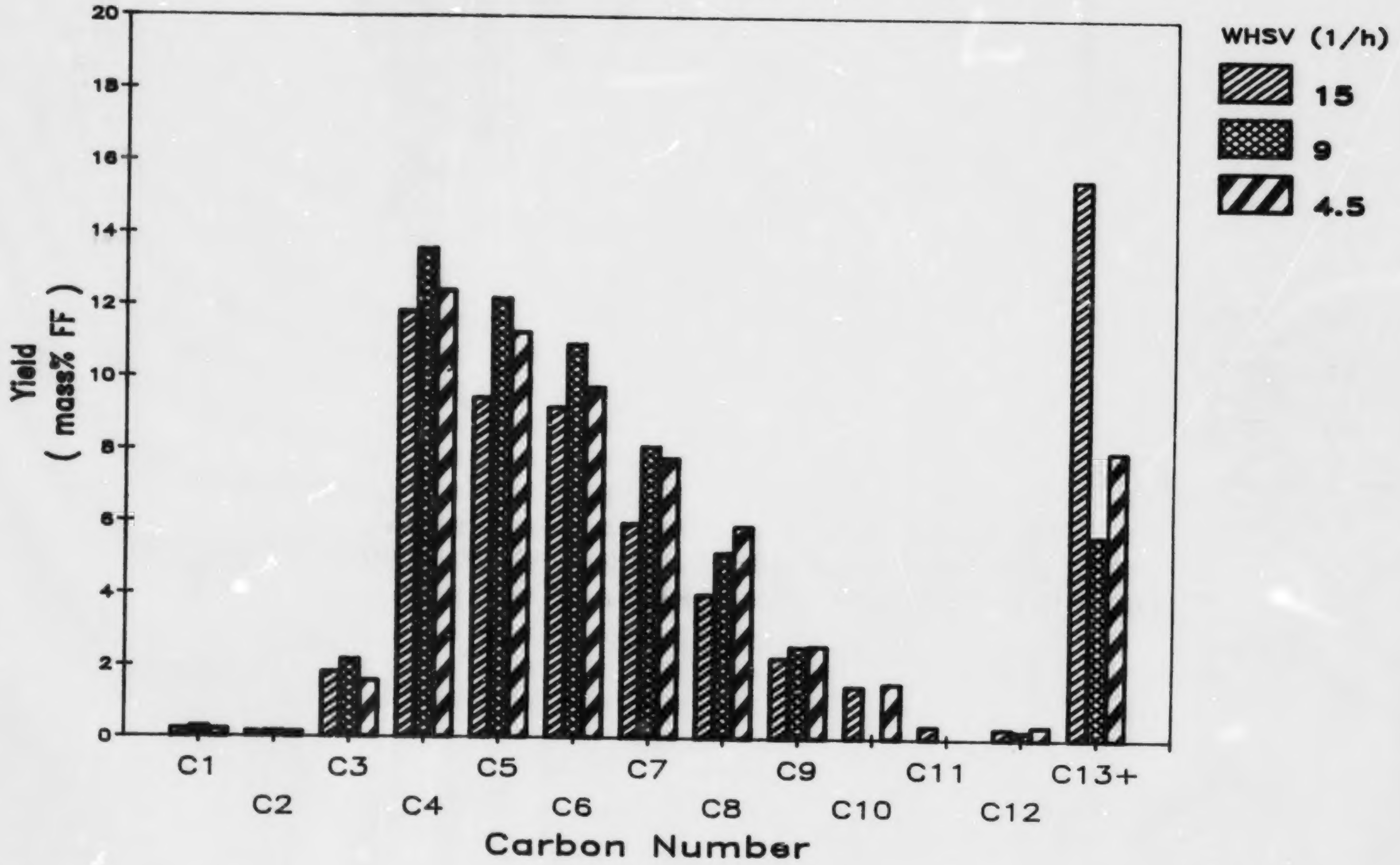


C1847CD

Task 1. Cracking Yields for Normal Paraffins

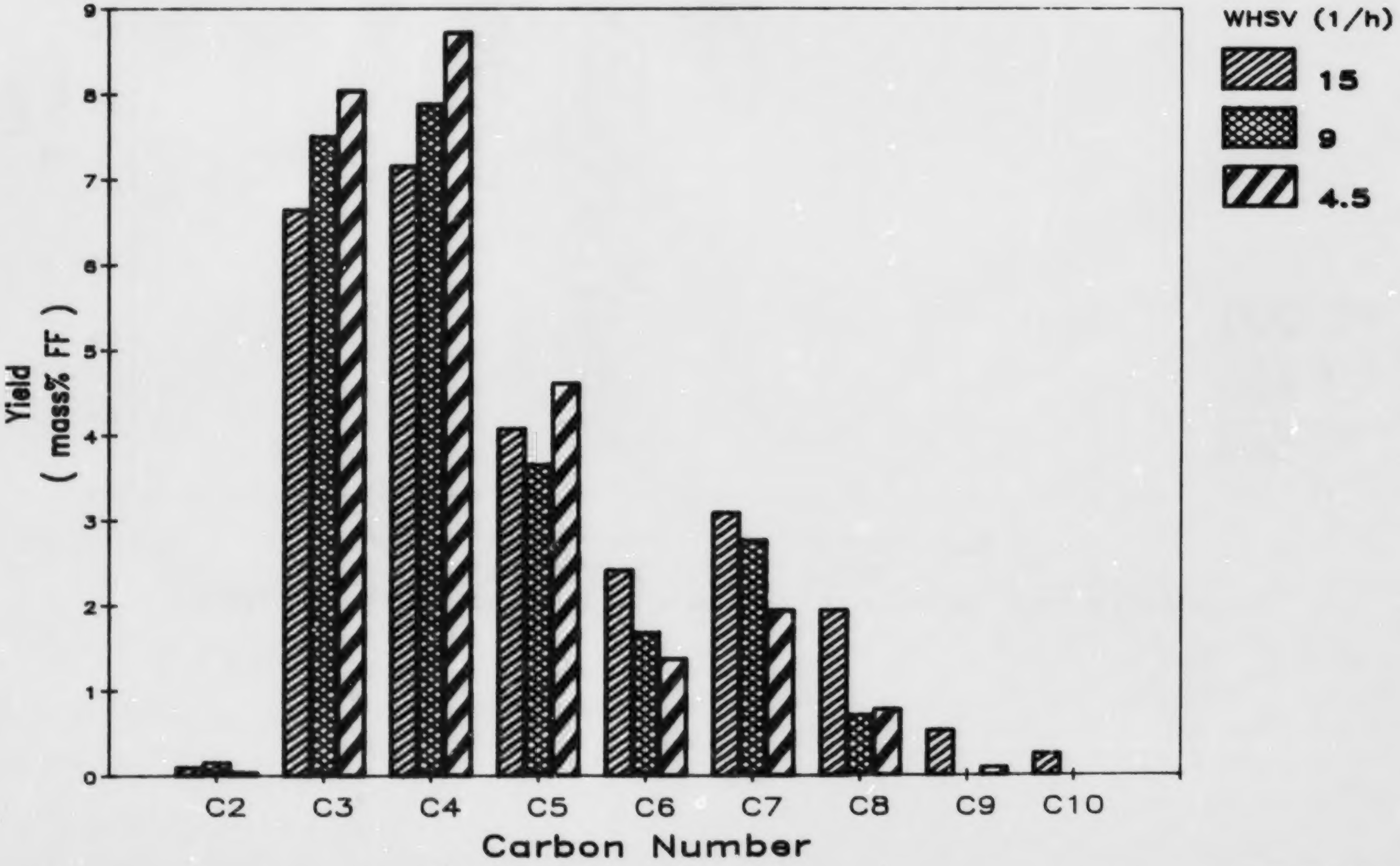
PARAFFIN DISTRIBUTION

Feed : Octadecane   RX. TEMP : 475 C



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Octadecane RX. TEMP : 475 C

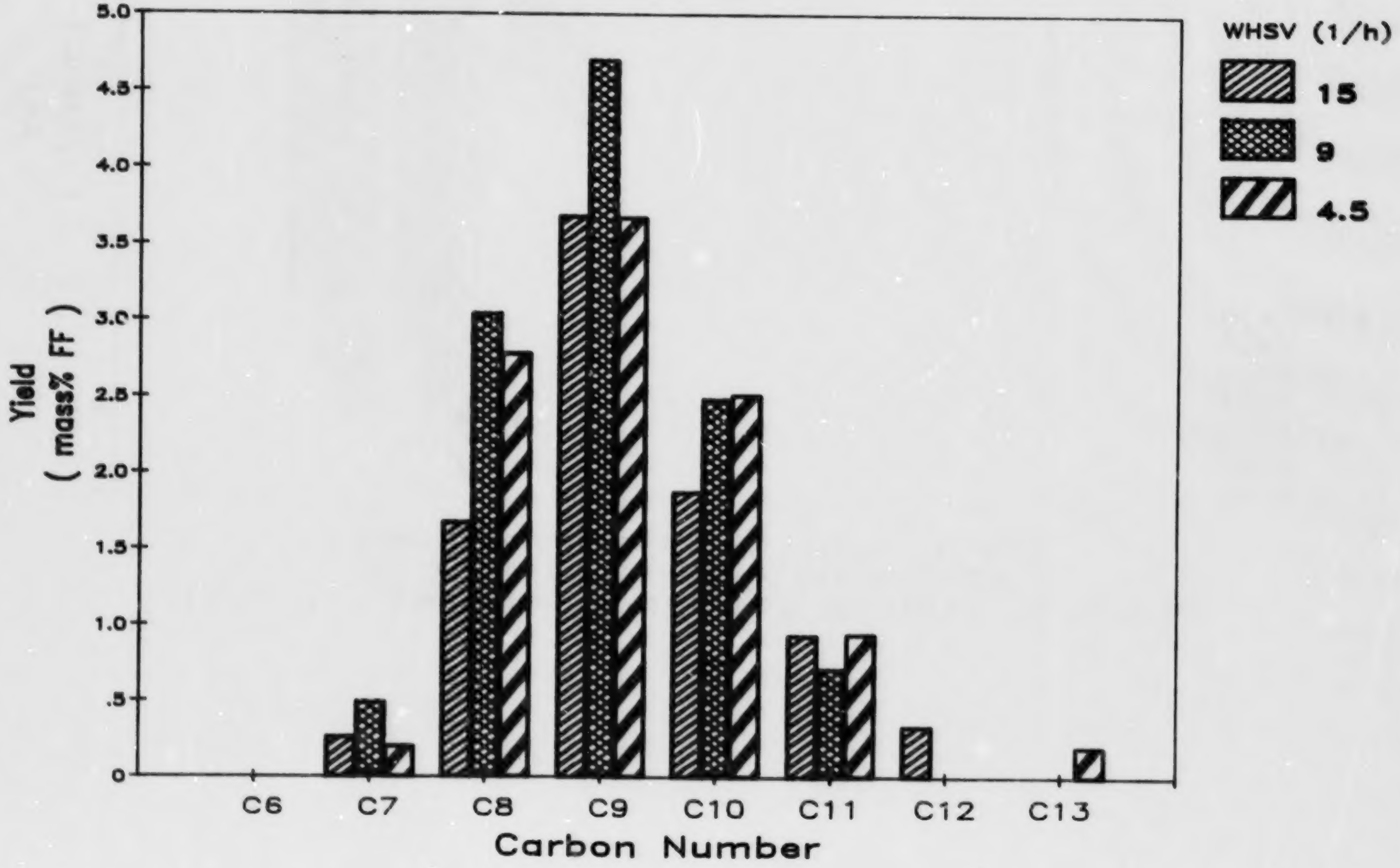


T1470C18

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

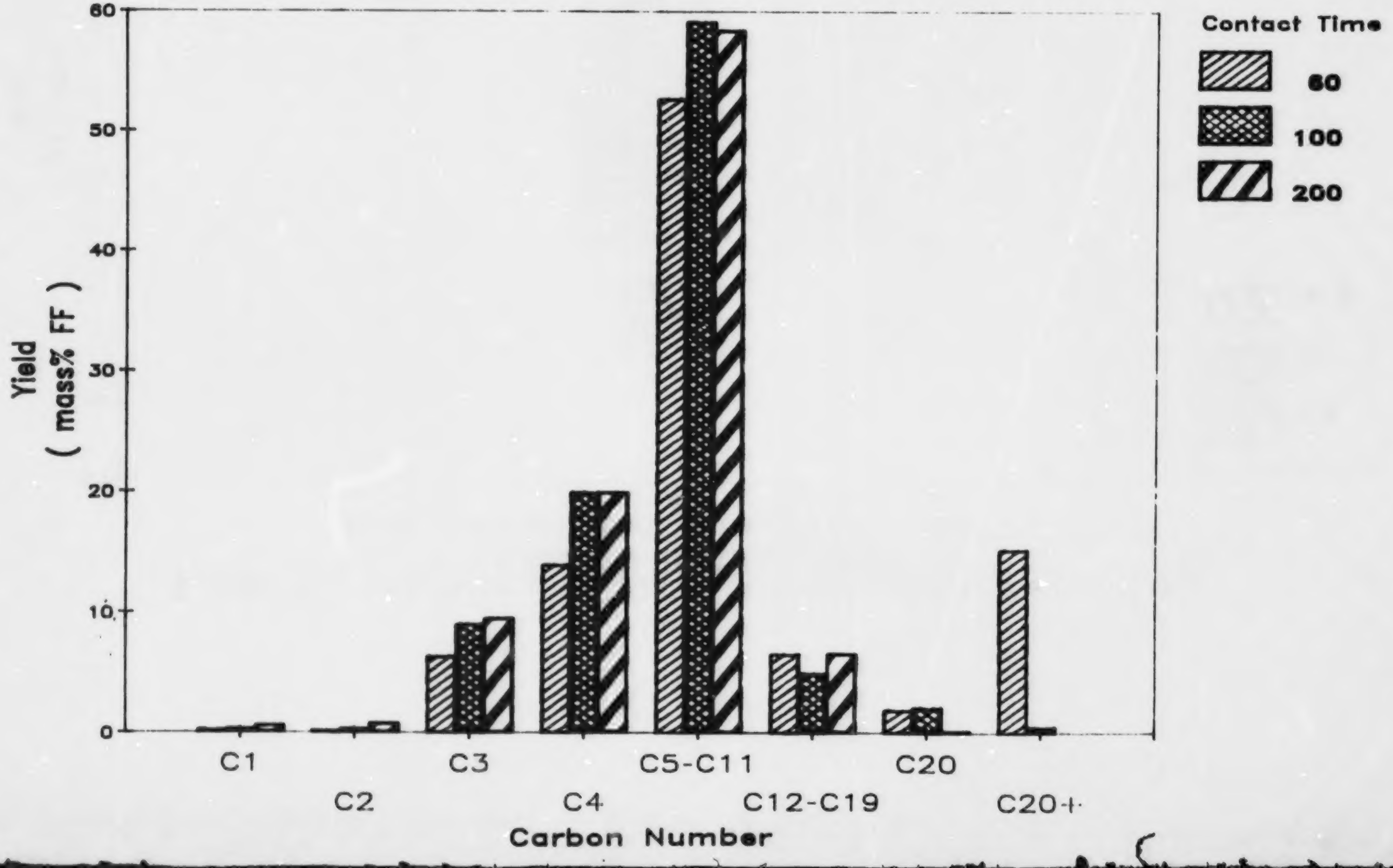
Feed : Octadecane   RX. TEMP : 475 C



T147AC18

Task 1. Cracking Yields for Normal Paraffins

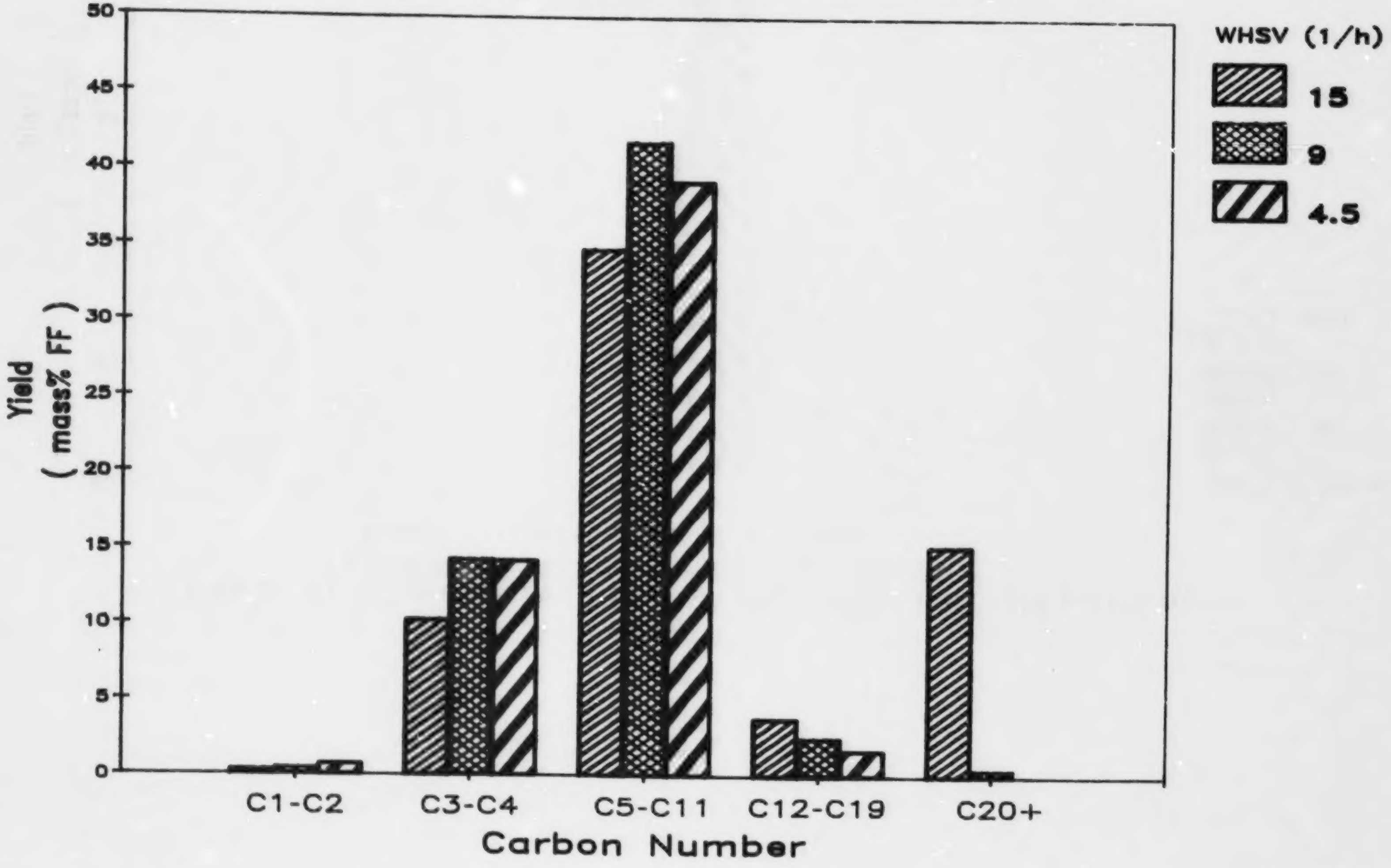
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexacosane Rx. Temp : 475 C



Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

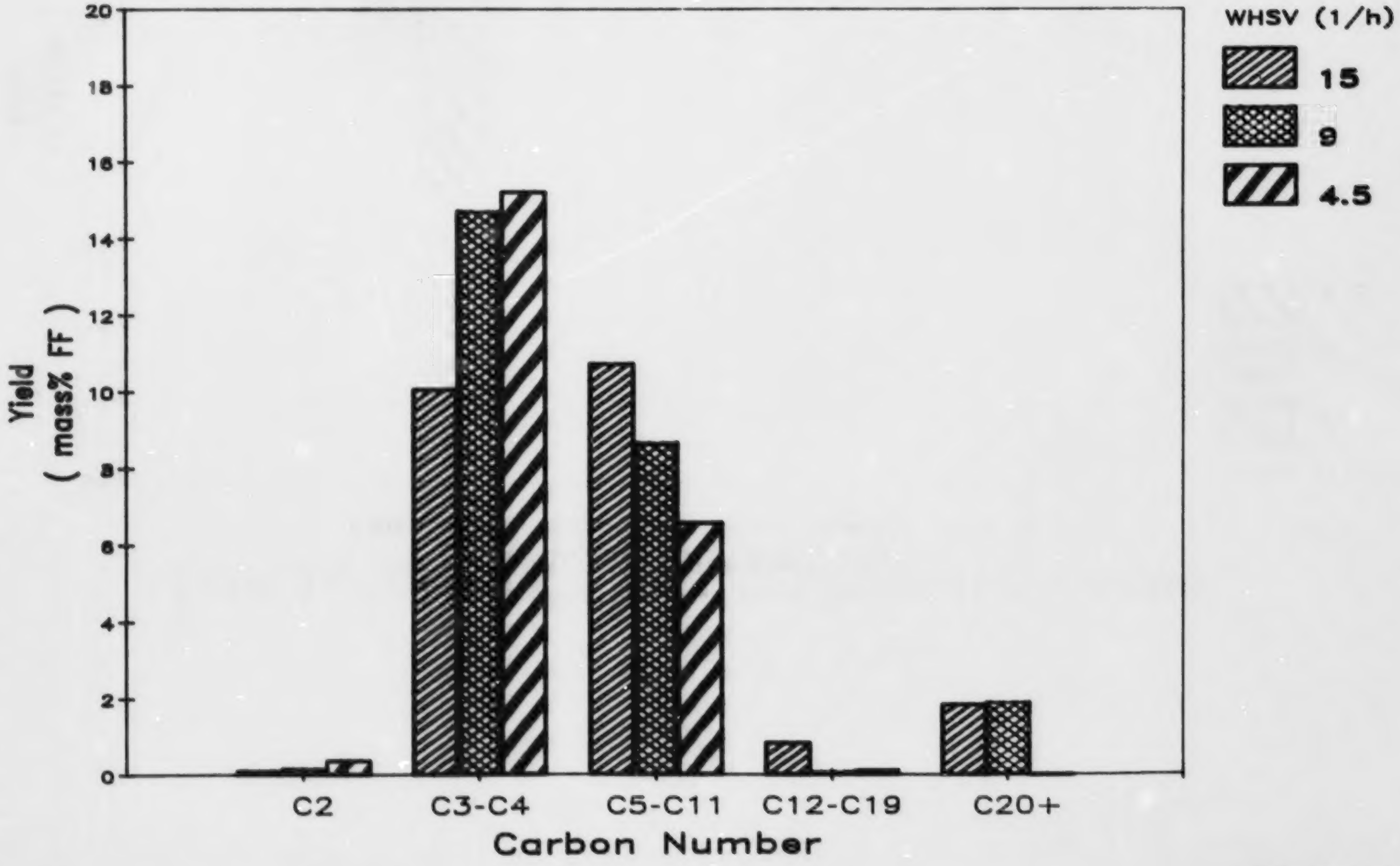
Feed : Hexacosane RX. TEMP : 475 C



T147PC26

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Hexacosane   RX. TEMP : 475 C

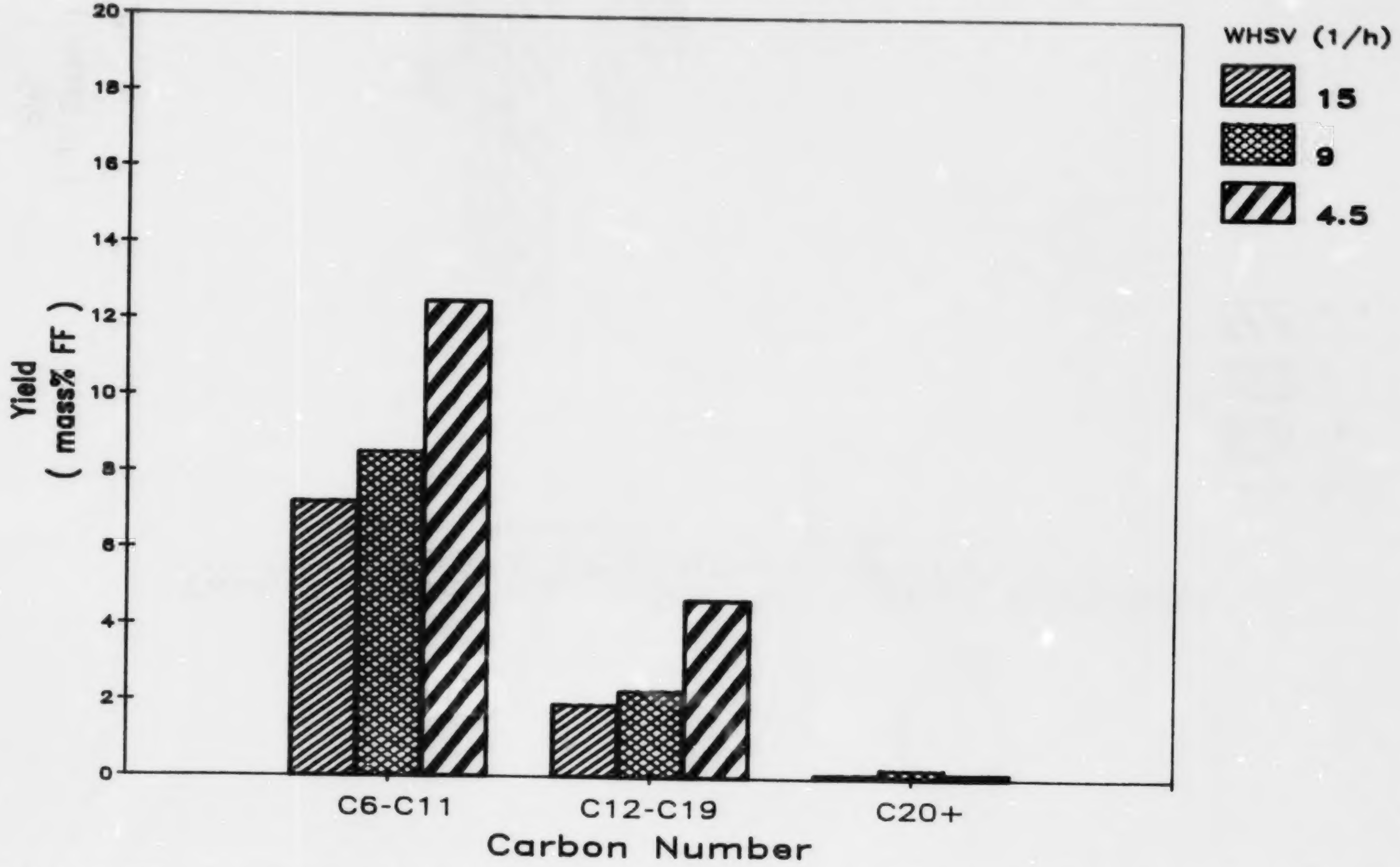


T1470C26

Task 1. Cracking Yields for Normal Paraffins

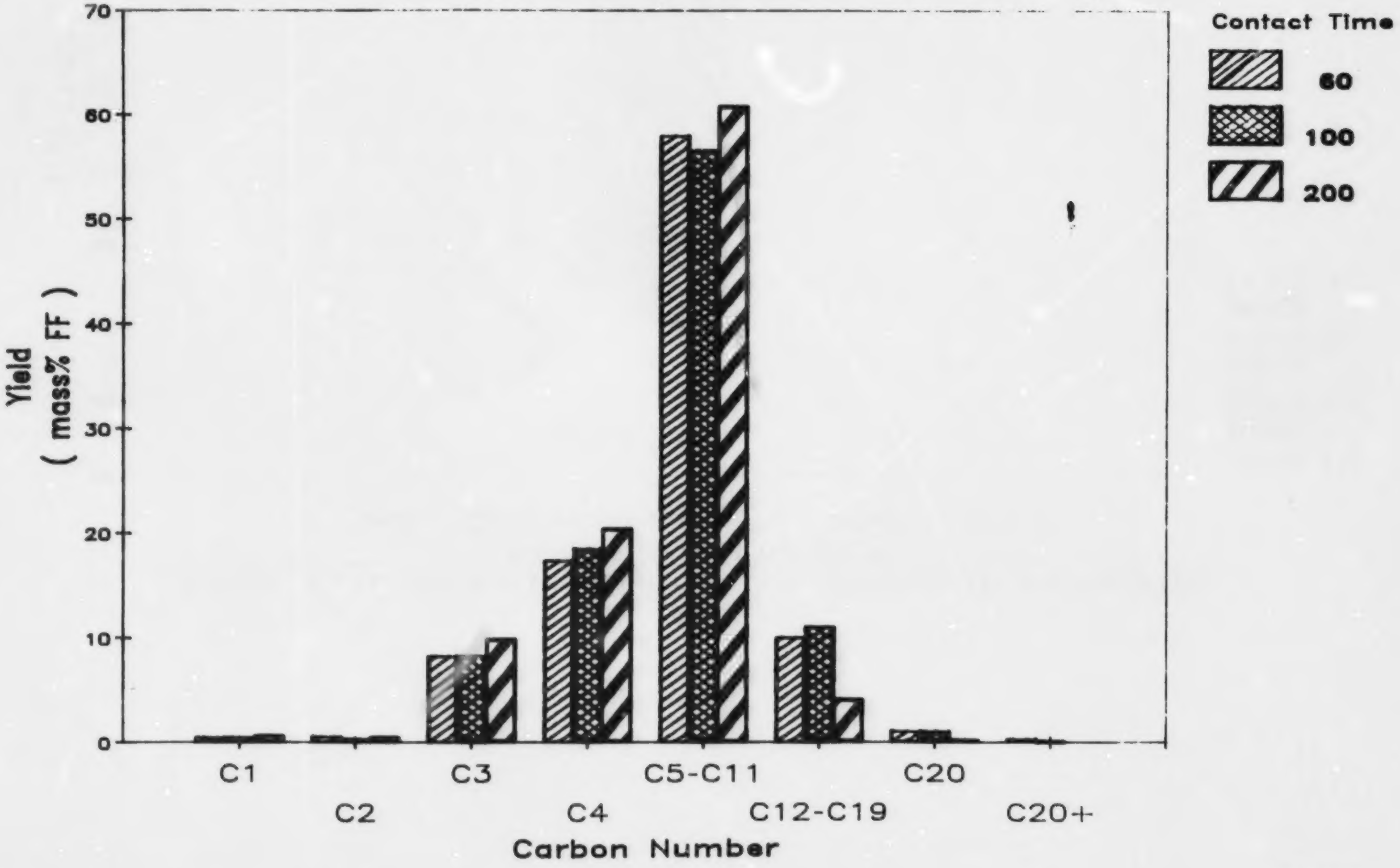
AROMATIC DISTRIBUTION

Feed : Hexacosane   RX. TEMP : 475 C



Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Dotriacontane Rx. Temp 475 C

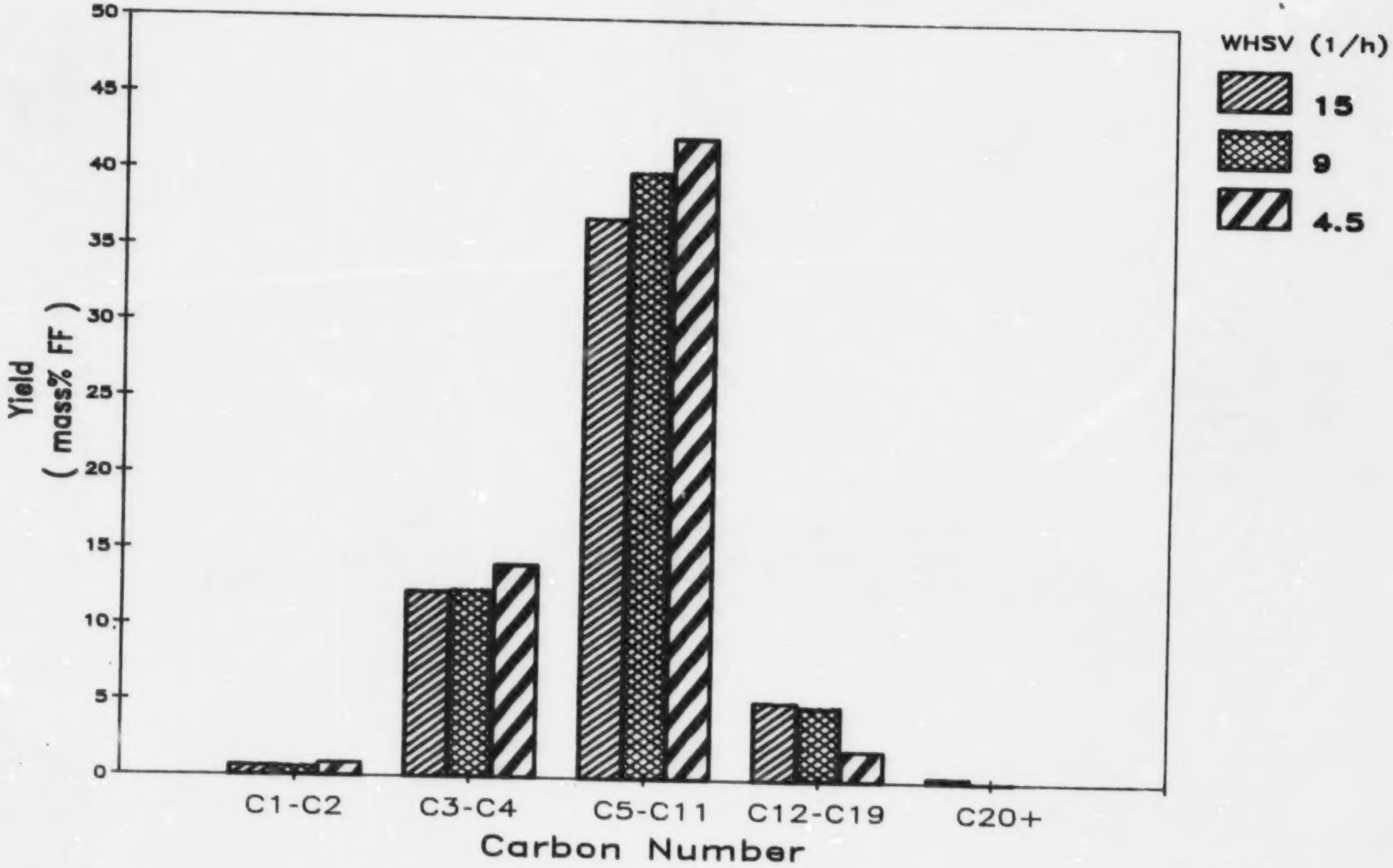


C3247CD

Task 1. Cracking Yields for Normal Paraffins

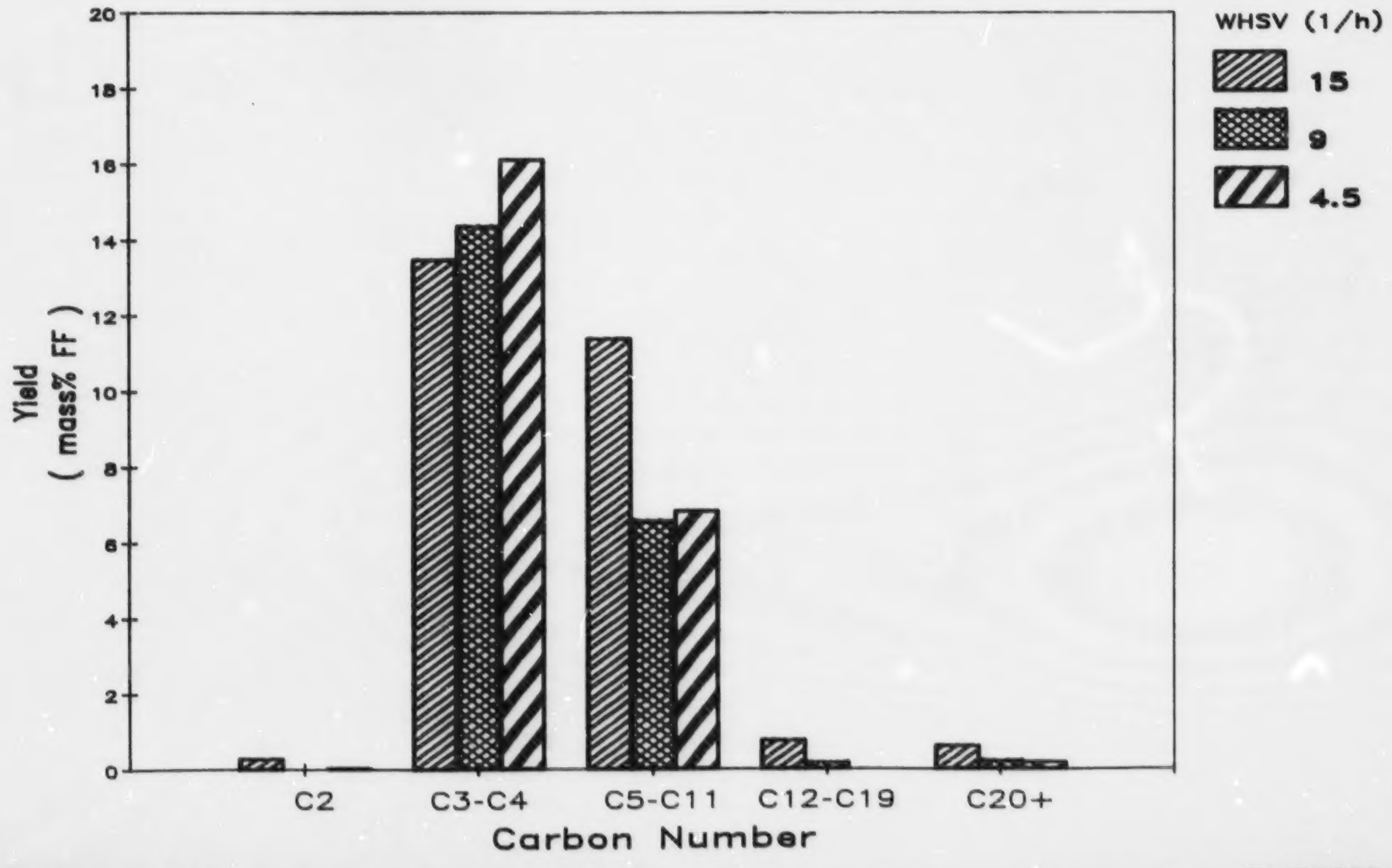
PARAFFIN DISTRIBUTION

Feed : Dotriacontane RX. TEMP : 475 C



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Dotriacontane   RX. TEMP : 475 C

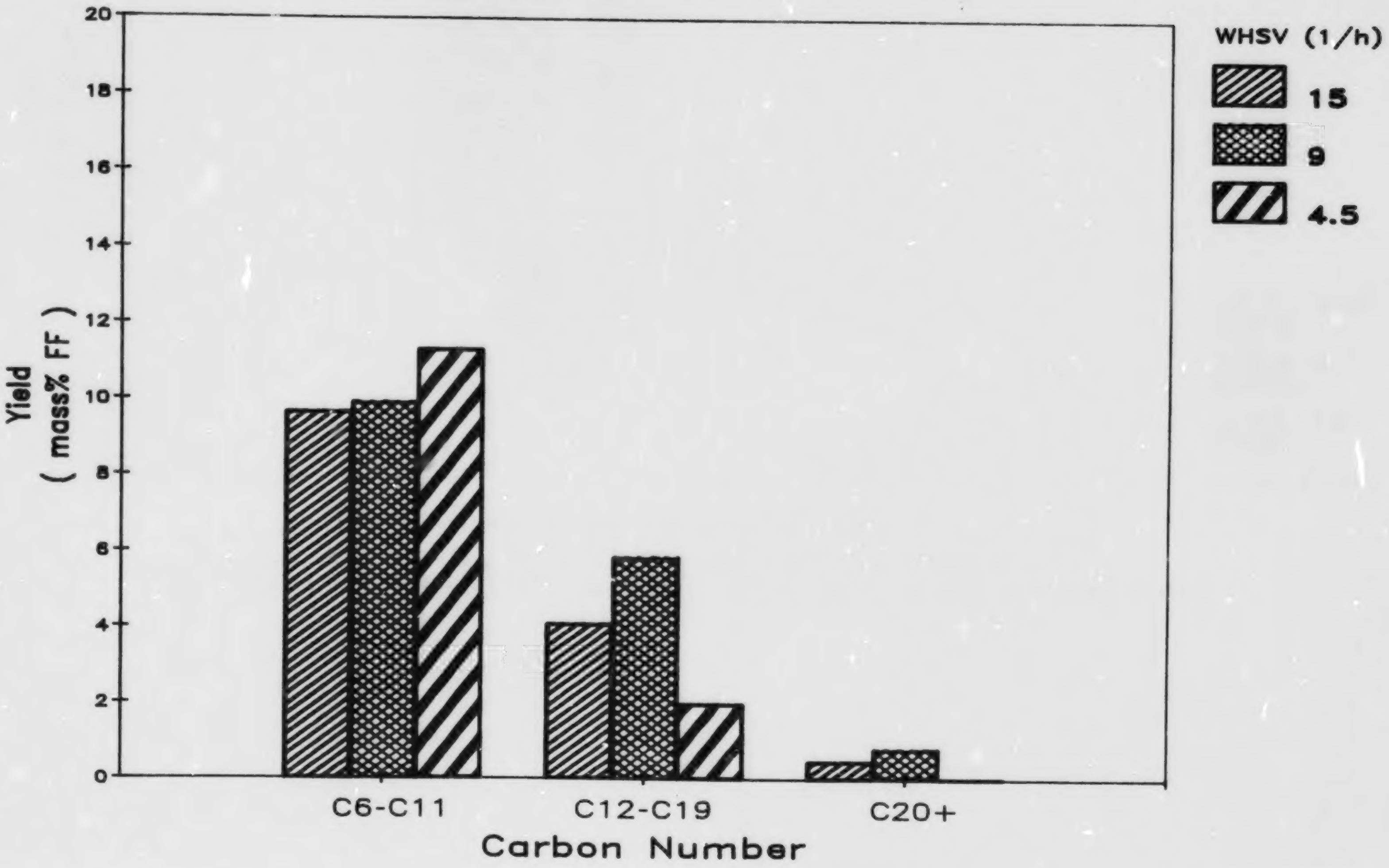


T1470C32

Task 1. Cracking Yields for Normal Paraffins

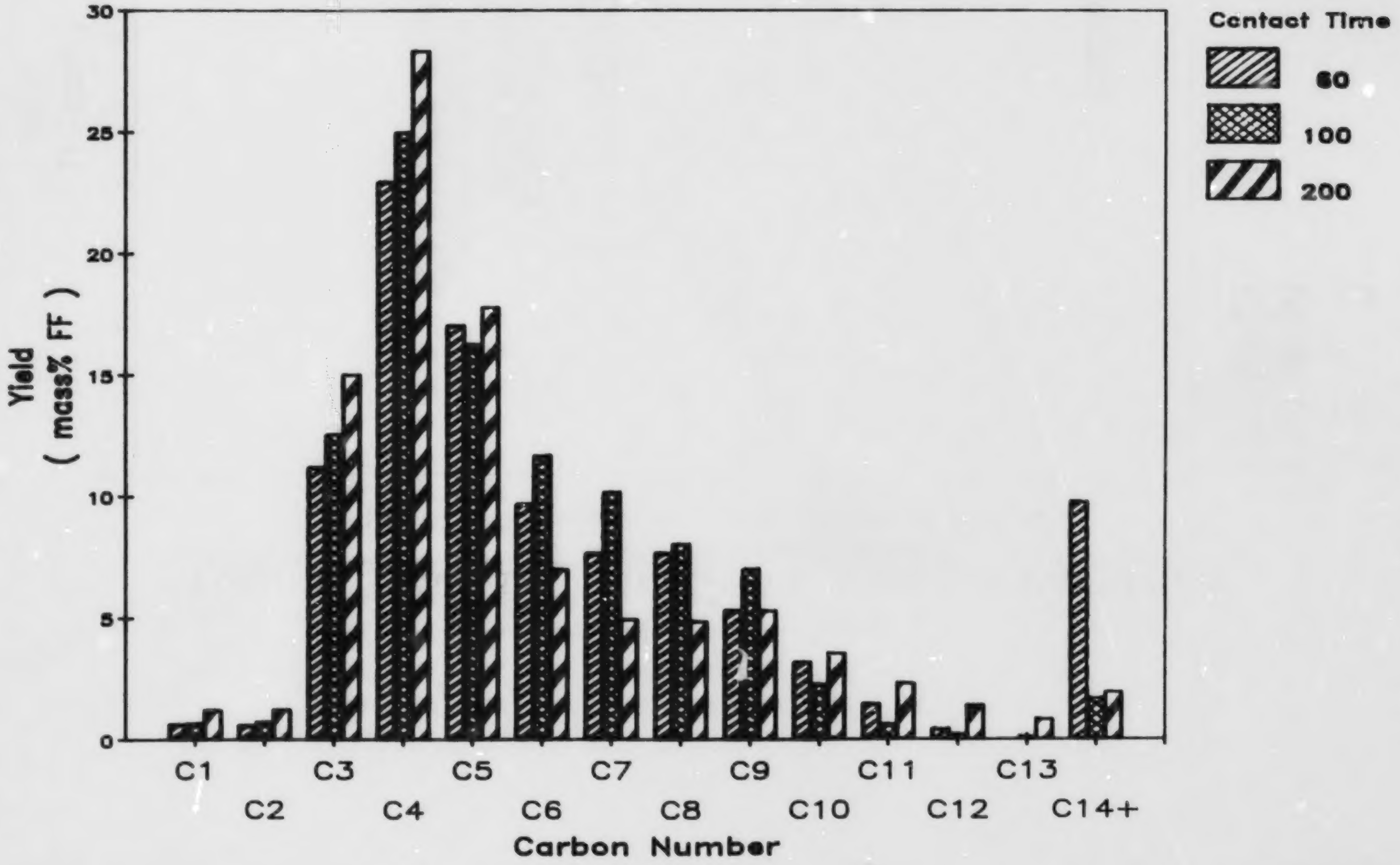
AROMATIC DISTRIBUTION

Feed : Dotriacontane   RX. TEMP : 475 C



Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Octadecane   Rx. Temp : 500 C

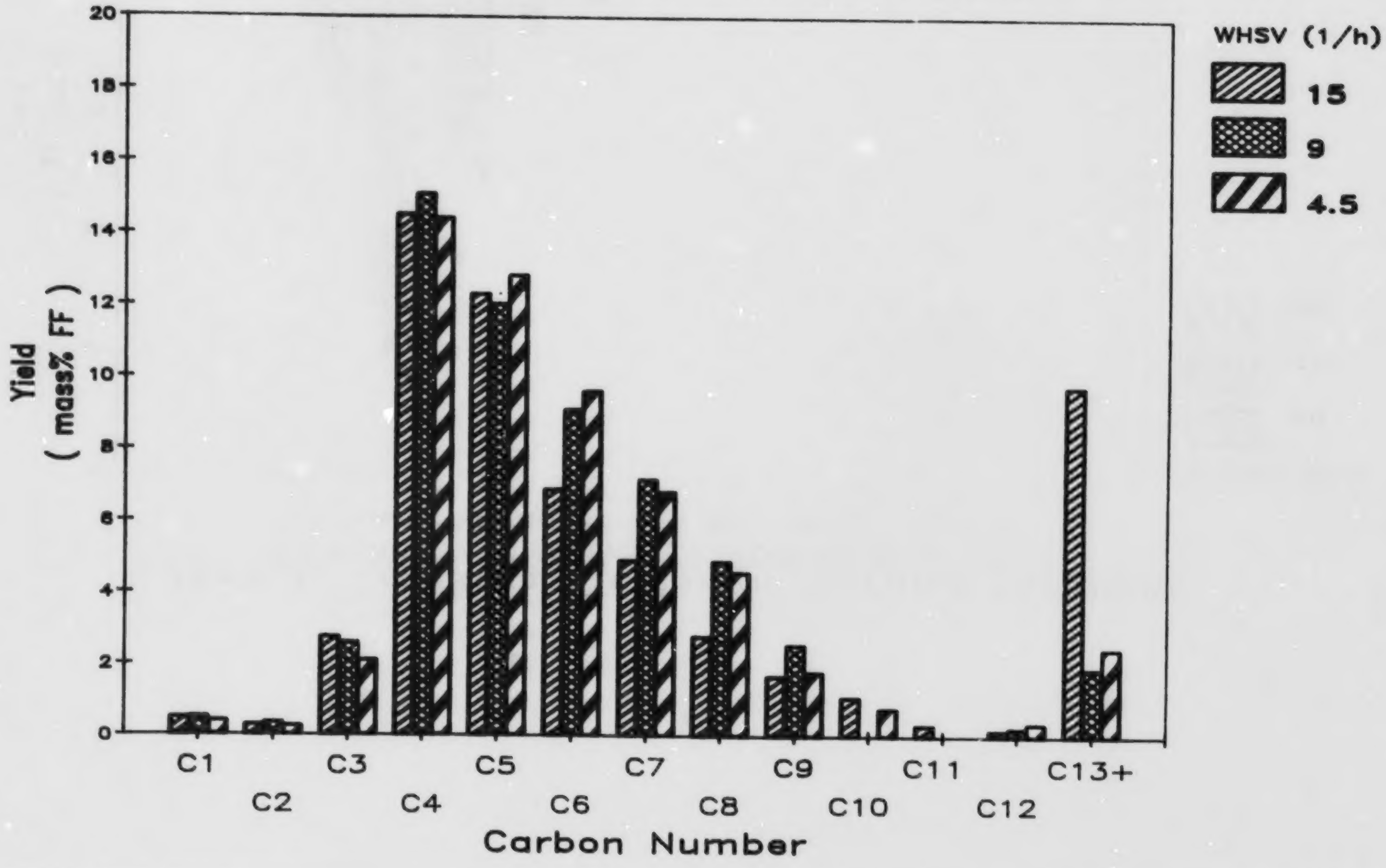


C1850CD

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

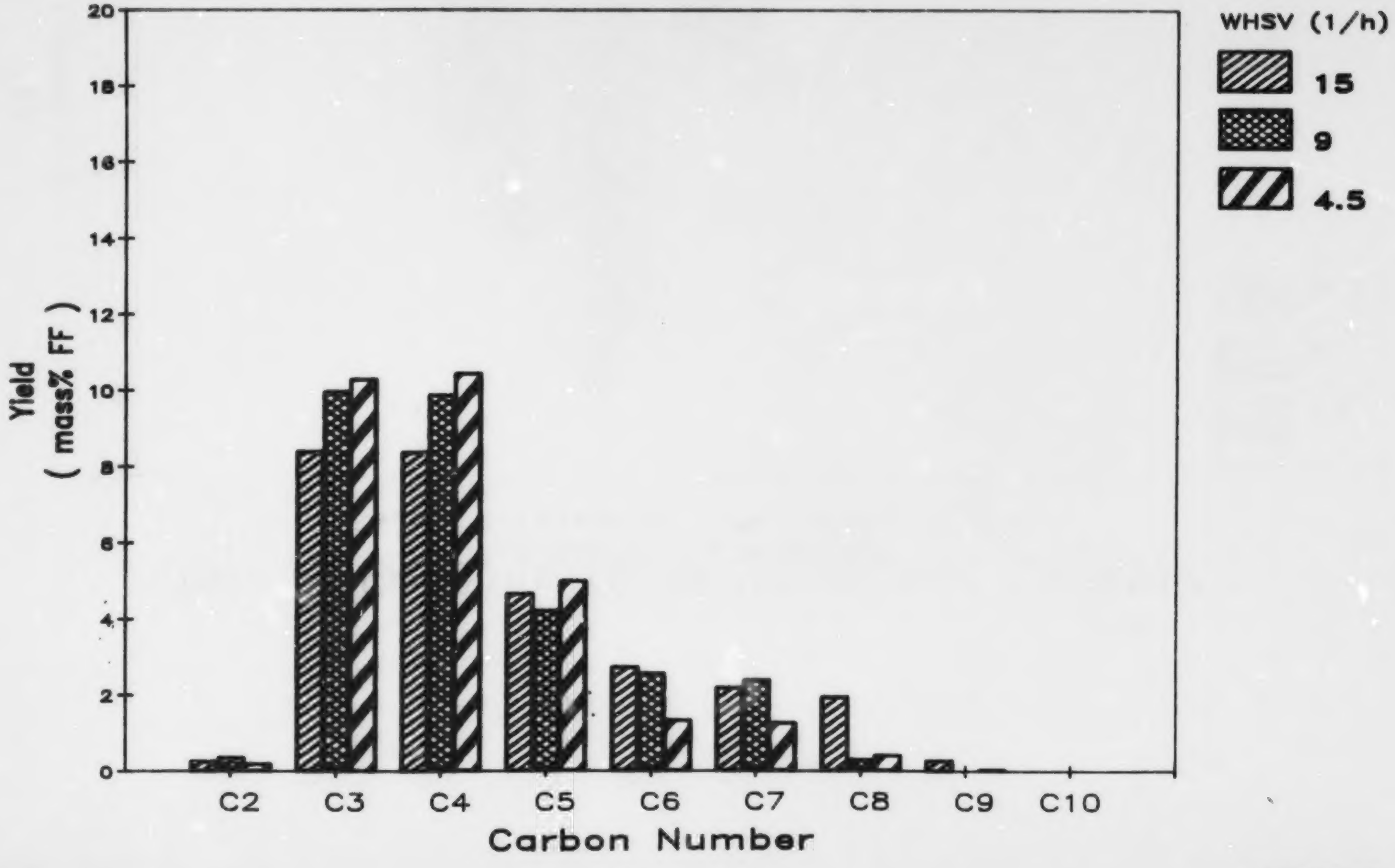
Feed : Octadecane   RX. TEMP : 500 C



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Octadecane   RX. TEMP : 500 C

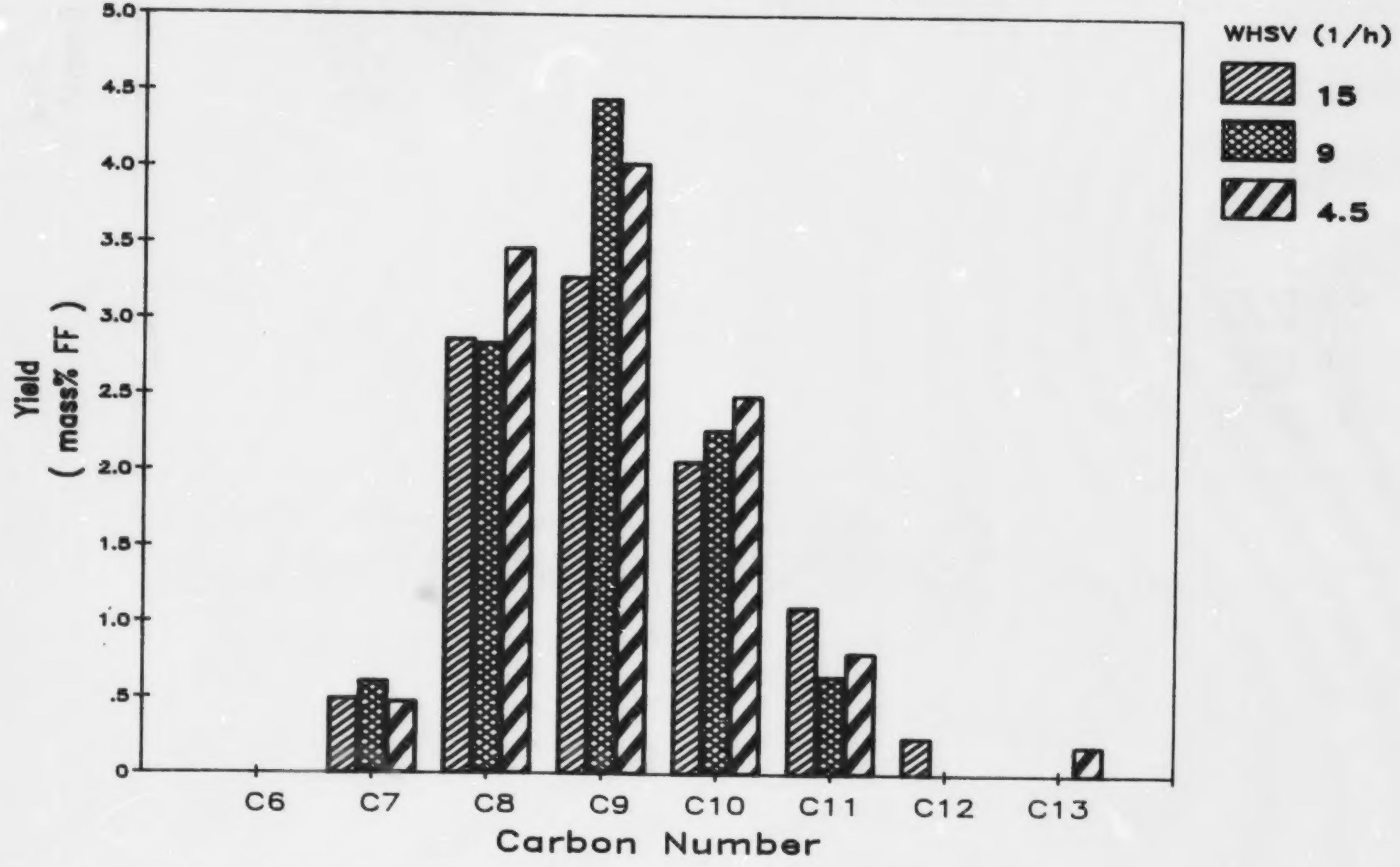


T1500C18

Task 1. Cracking Yields for Normal Paraffins

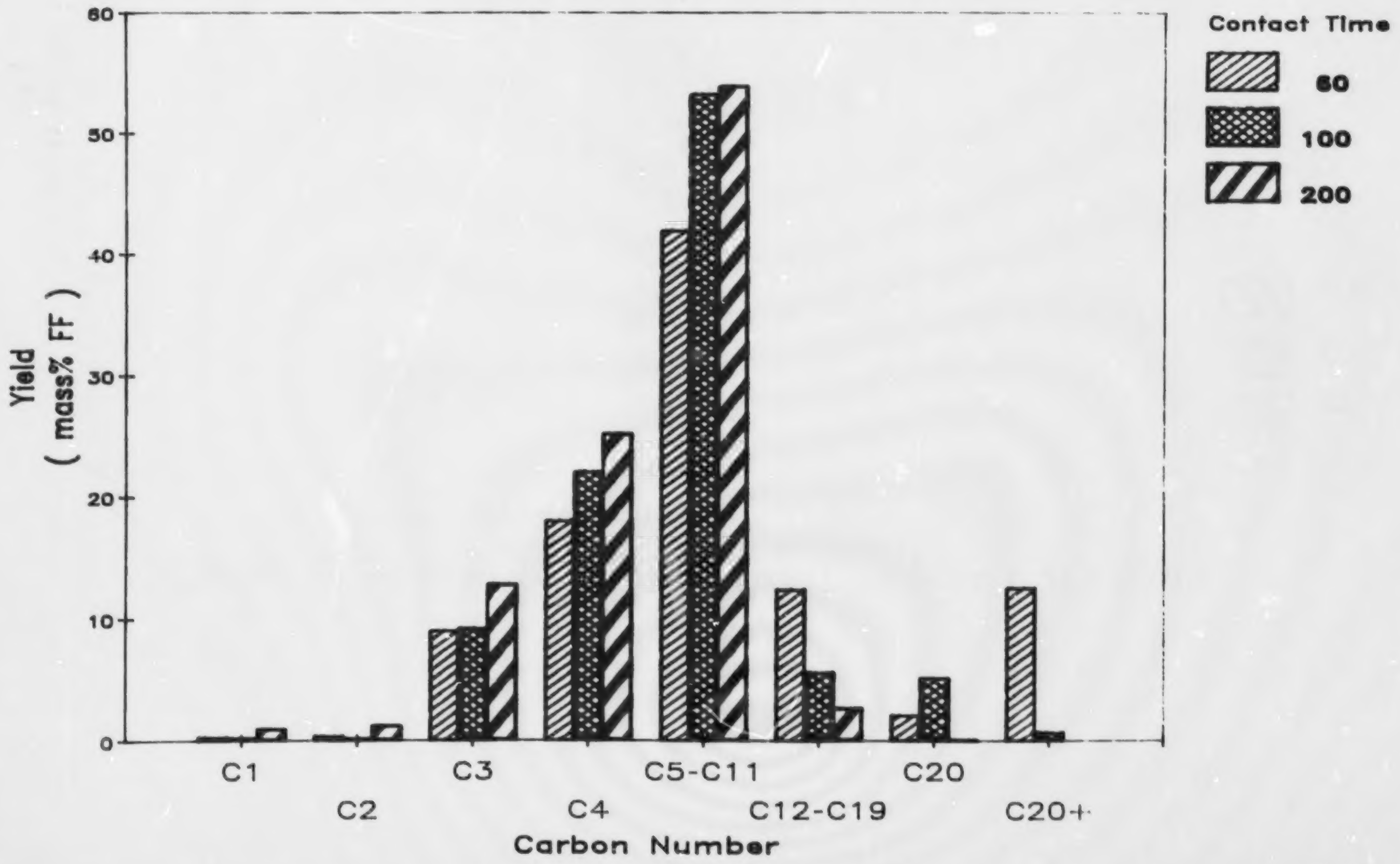
AROMATIC DISTRIBUTION

Feed : Octadecane RX. TEMP : 500 C



Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Hexacosane Rx. Temp : 500 C

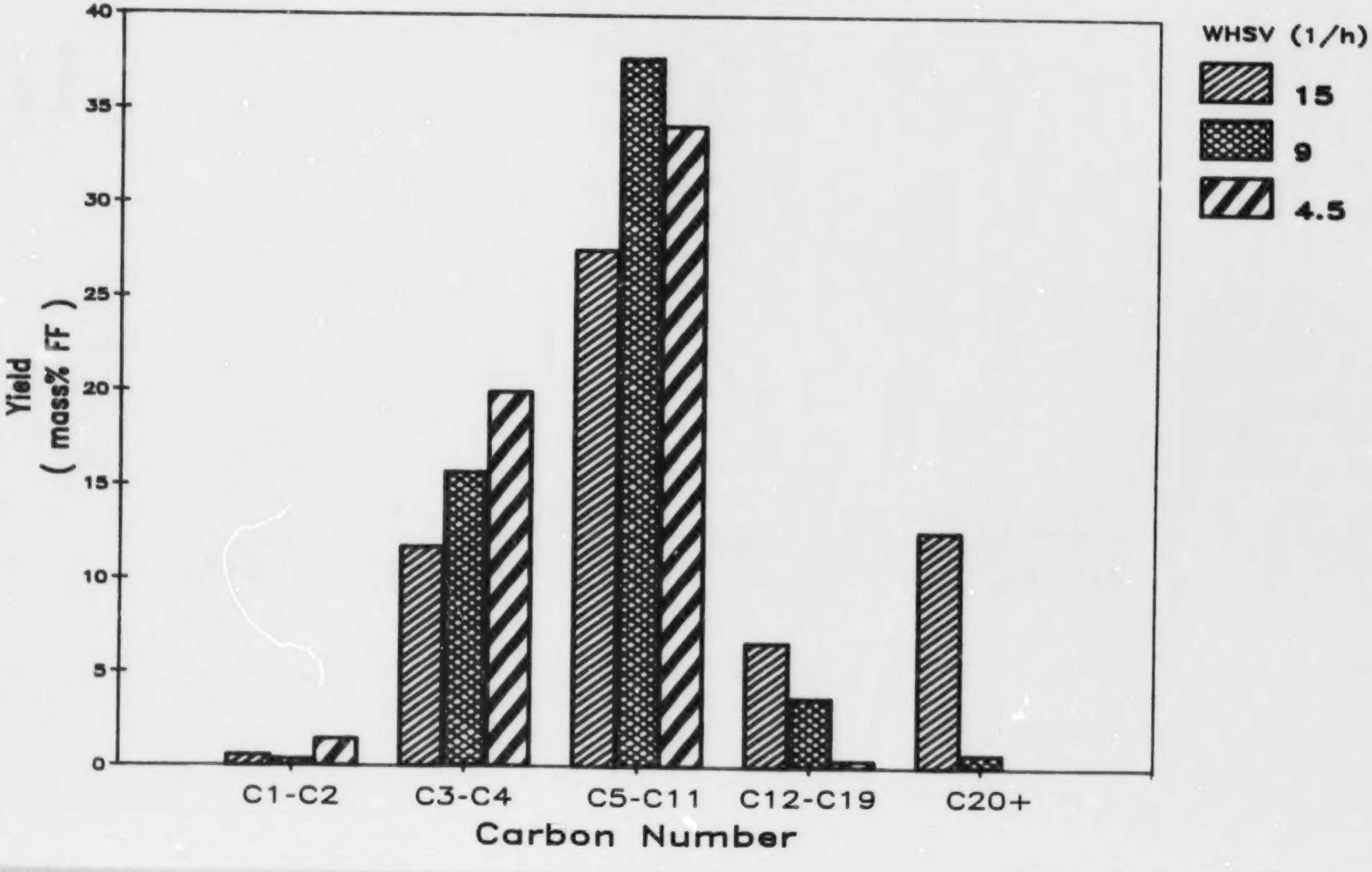


C2650CD

Task 1. Cracking Yields for Normal Paraffins

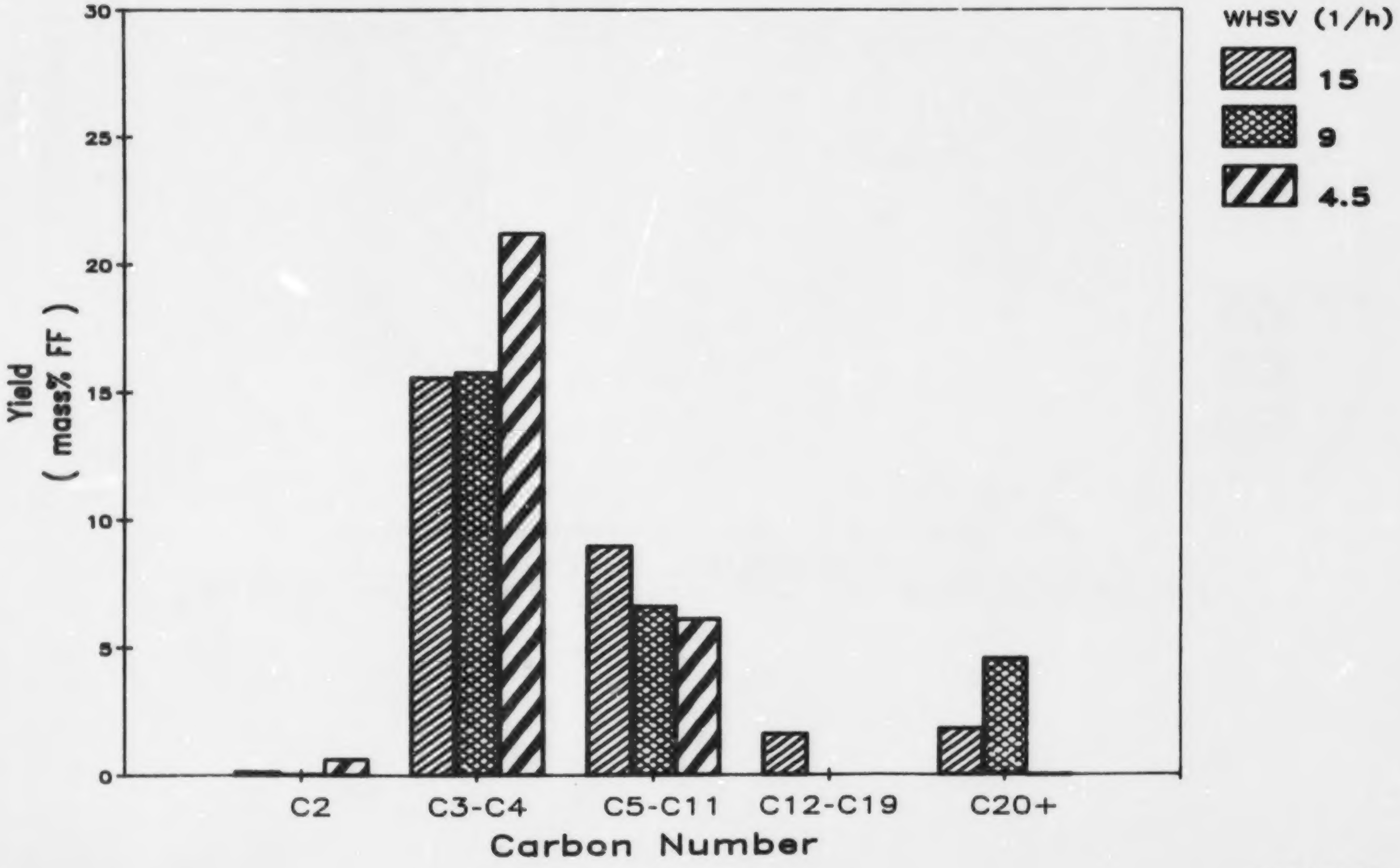
PARAFFIN DISTRIBUTION

Feed : Hexacosane   RX. TEMP : 500 C



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Hexacosane   RX. TEMP : 500 C

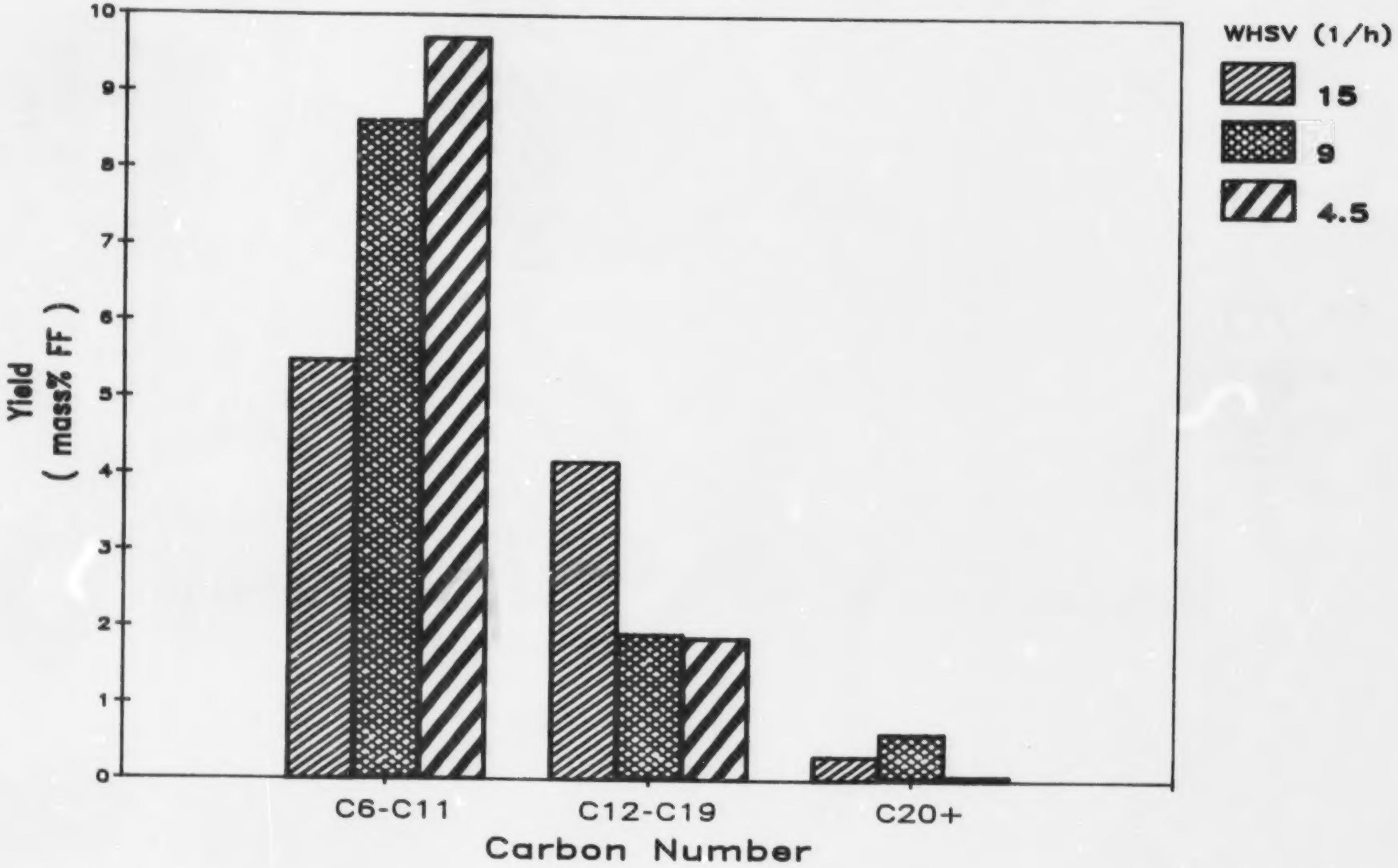


T1500C26

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

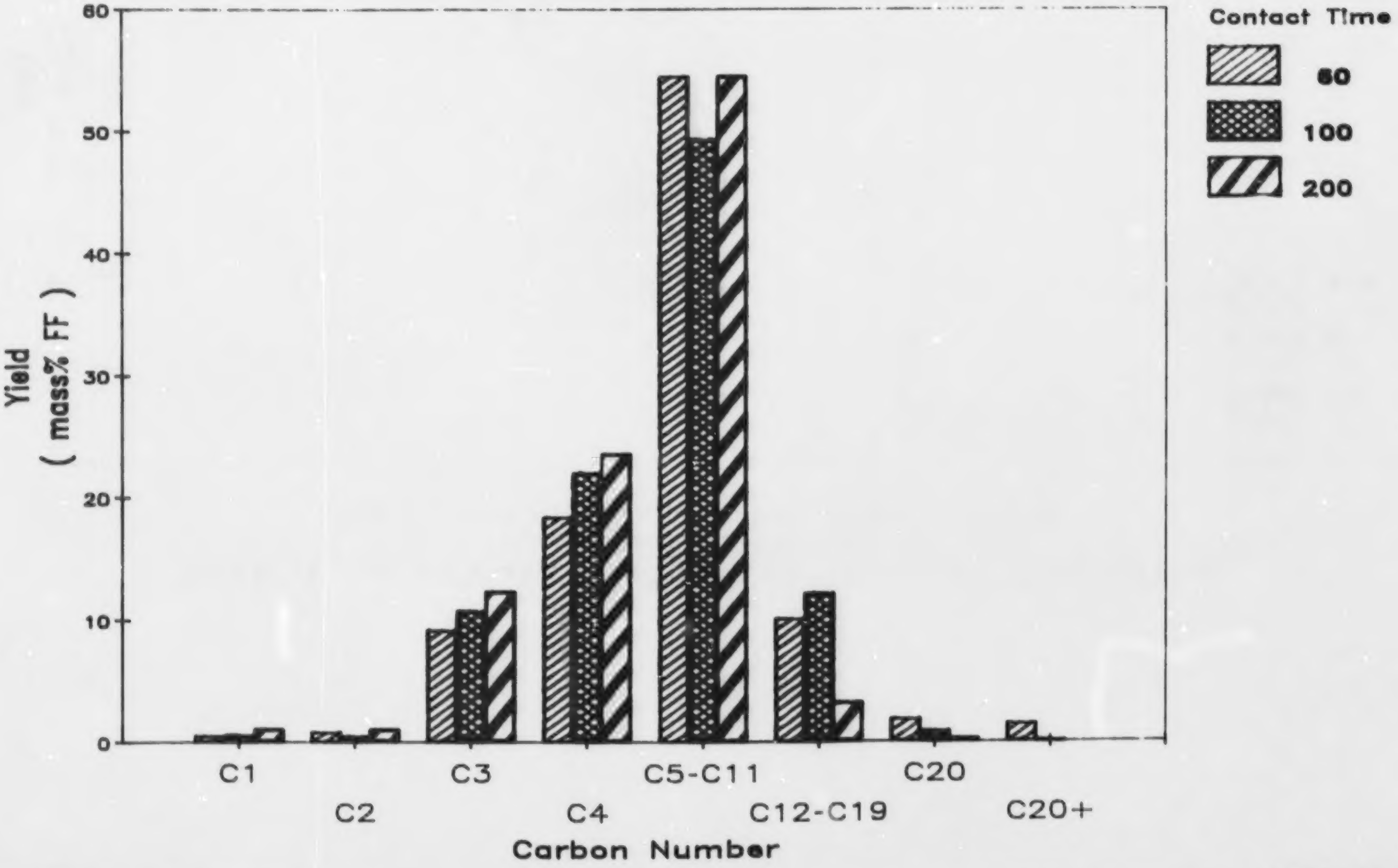
Feed : Hexacosane   RX. TEMP : 500 C



T150AC26

Task 1. Cracking Yields for Normal Paraffins

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Dotriacontane Rx. Temp 500 C

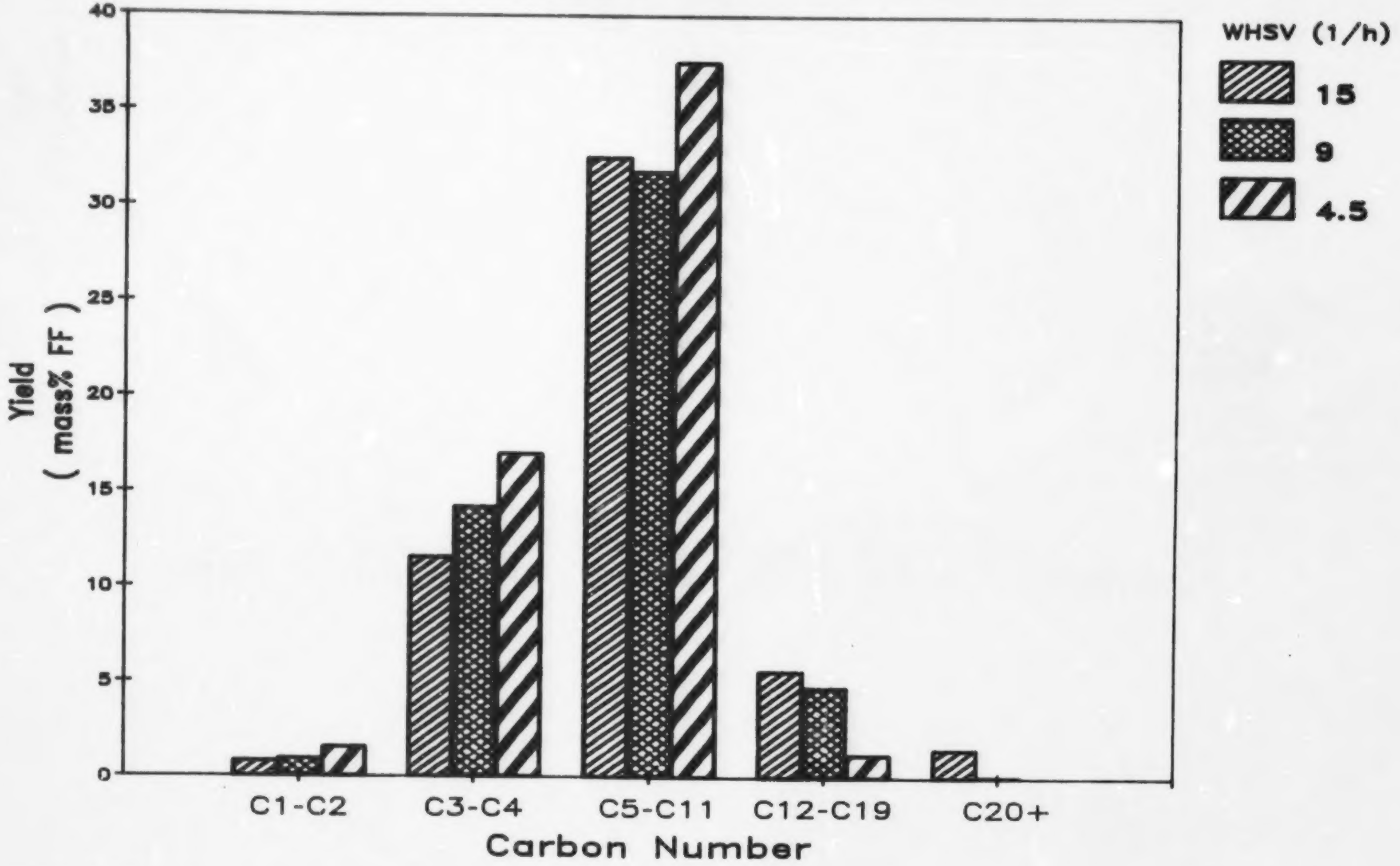


C3250CD

Task 1. Cracking Yields for Normal Paraffins

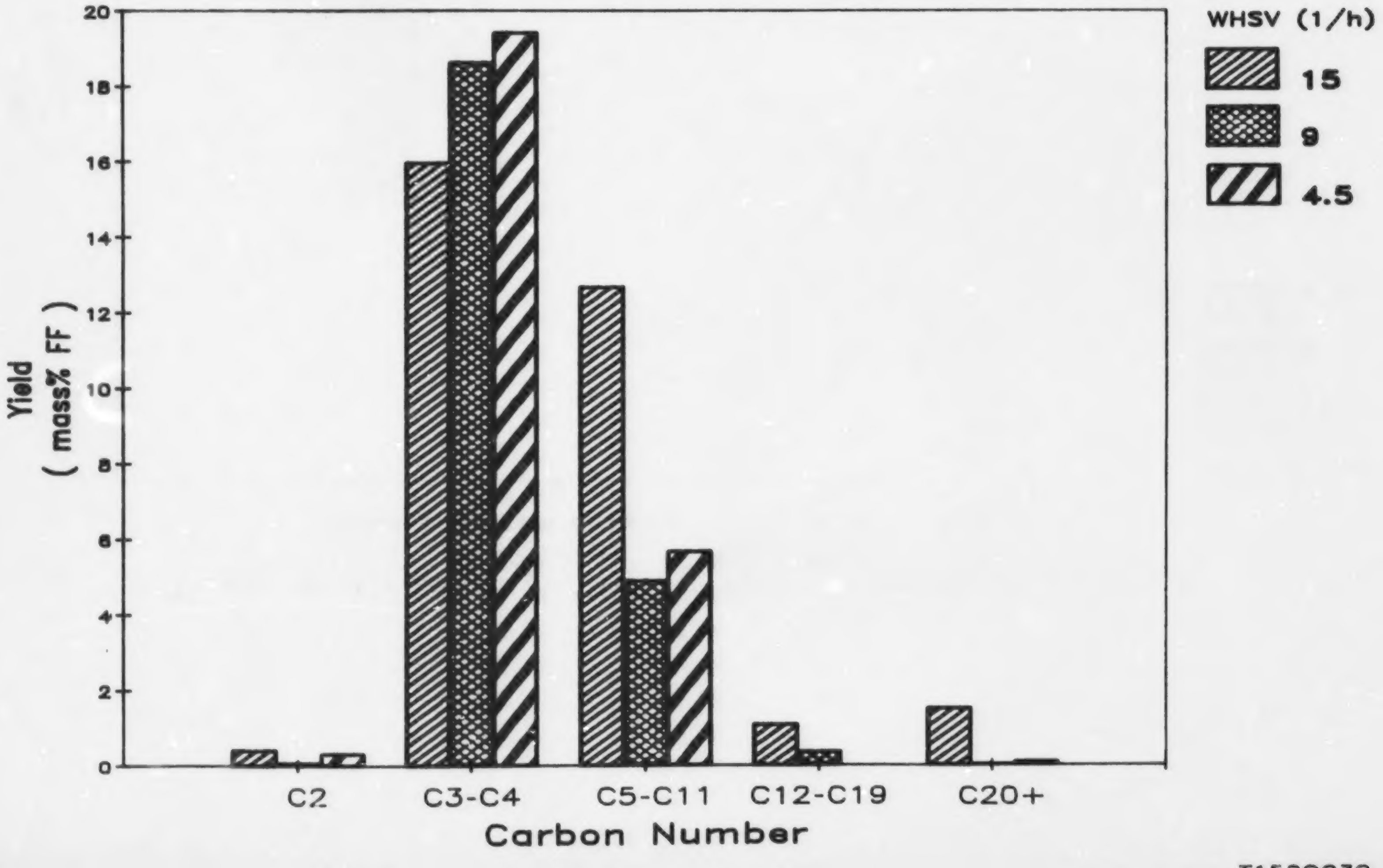
PARAFFIN DISTRIBUTION

Feed : Dotriacontane   RX. TEMP : 500 C



Task 1. Cracking Yields for Normal Paraffins

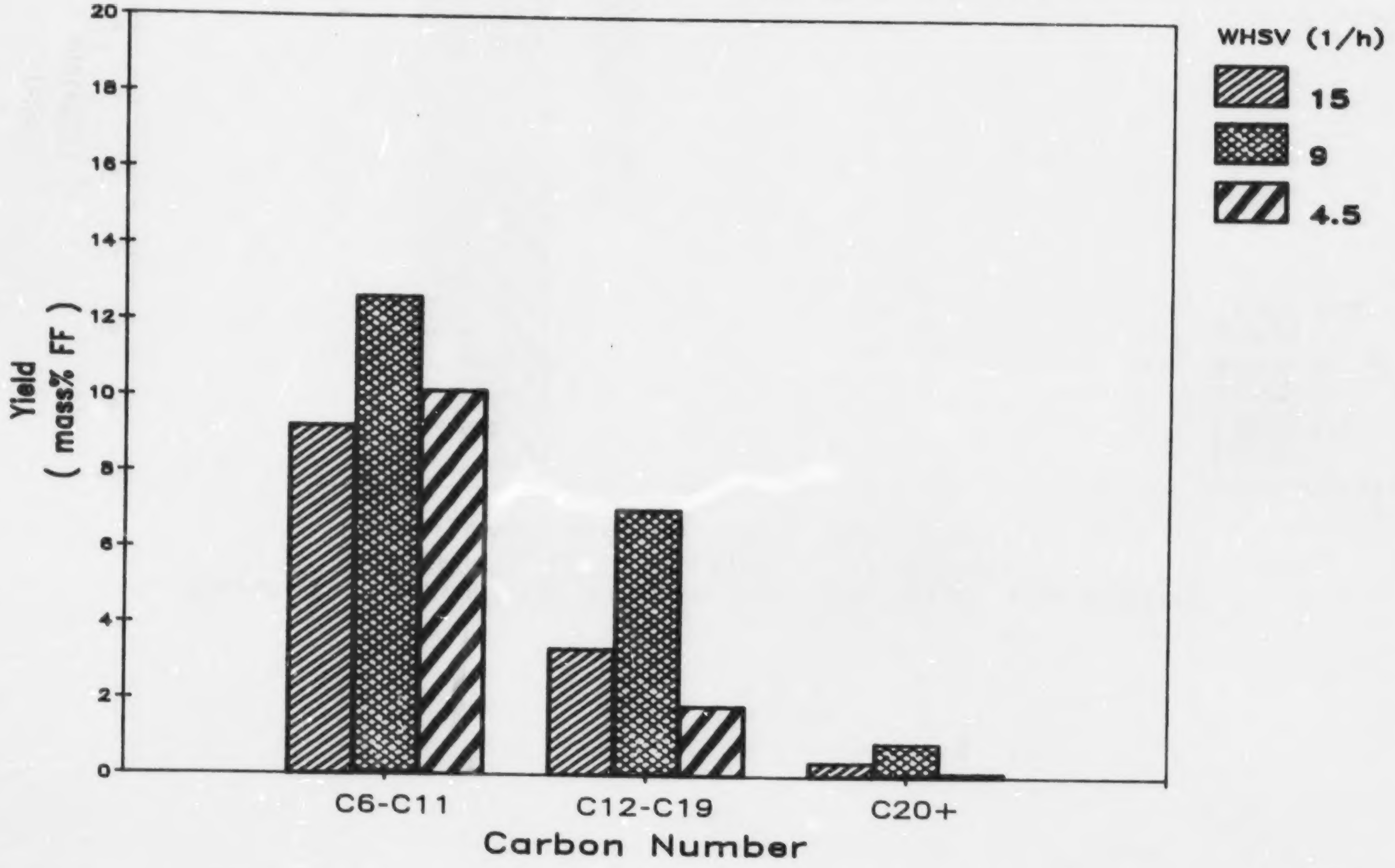
OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Dotriacontane RX. TEMP : 500 C



Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Dotriacontane RX. TEMP : 500 C

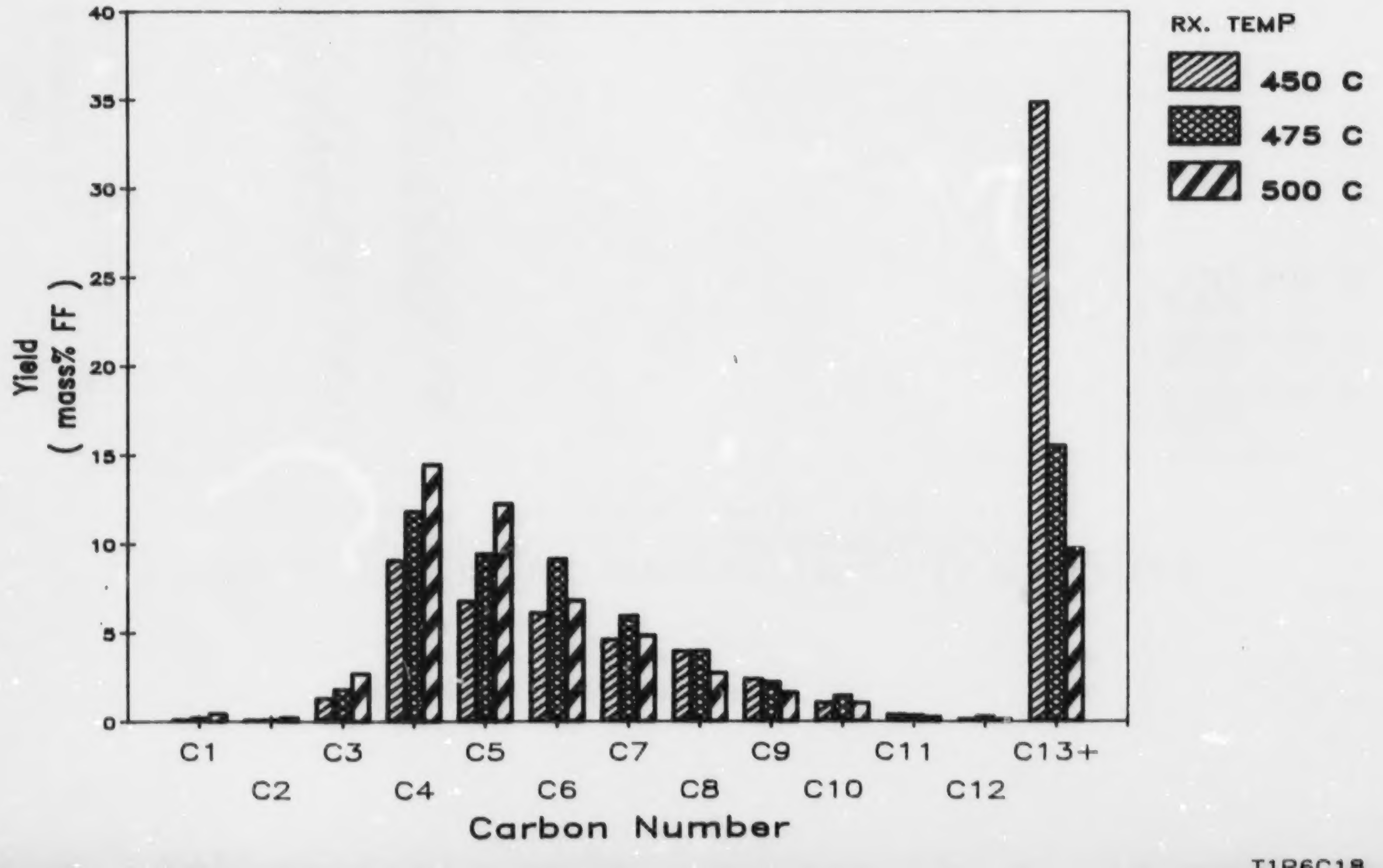


T150AC32

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

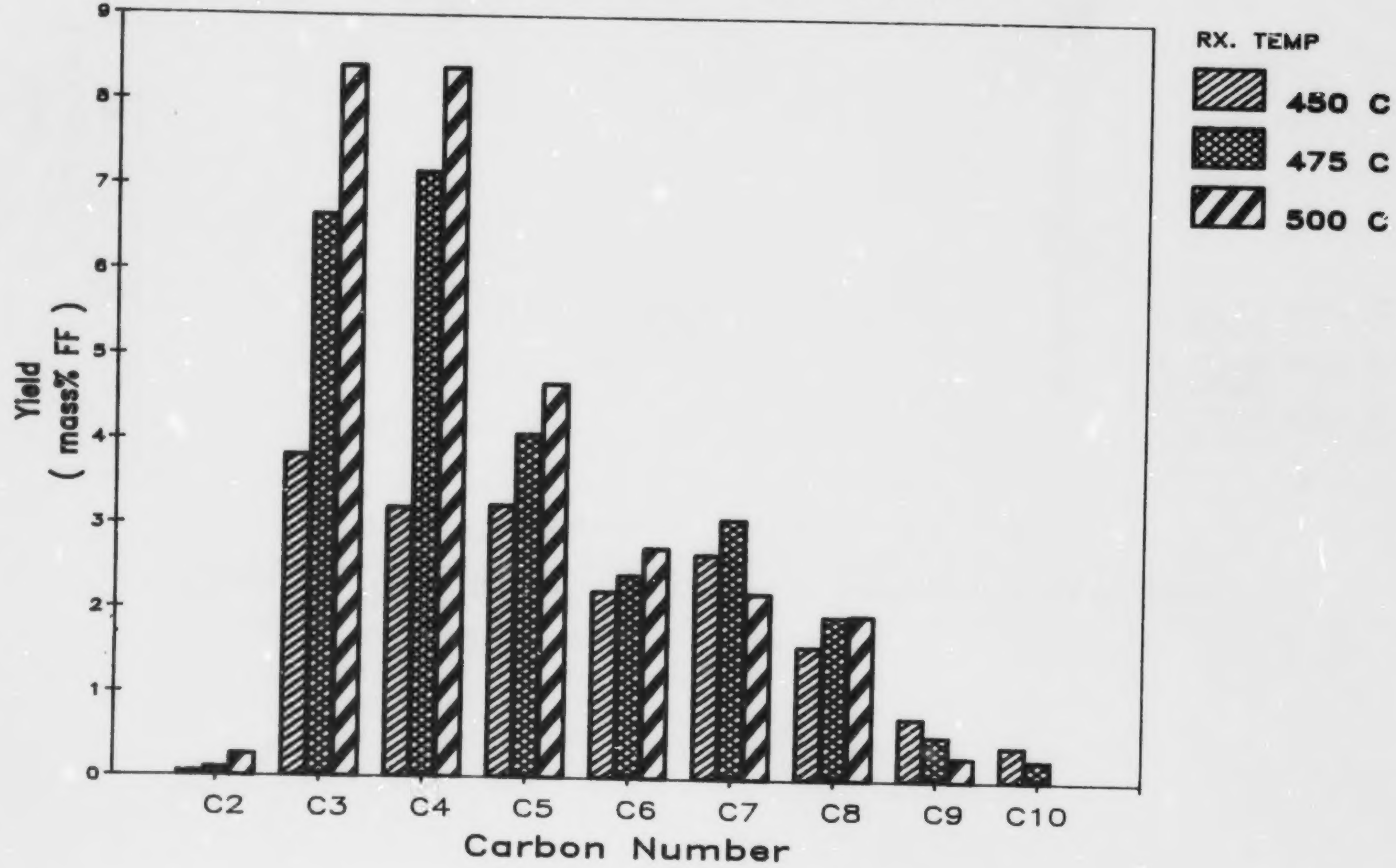
Feed : Octadecane WHSV (1/h) : 15

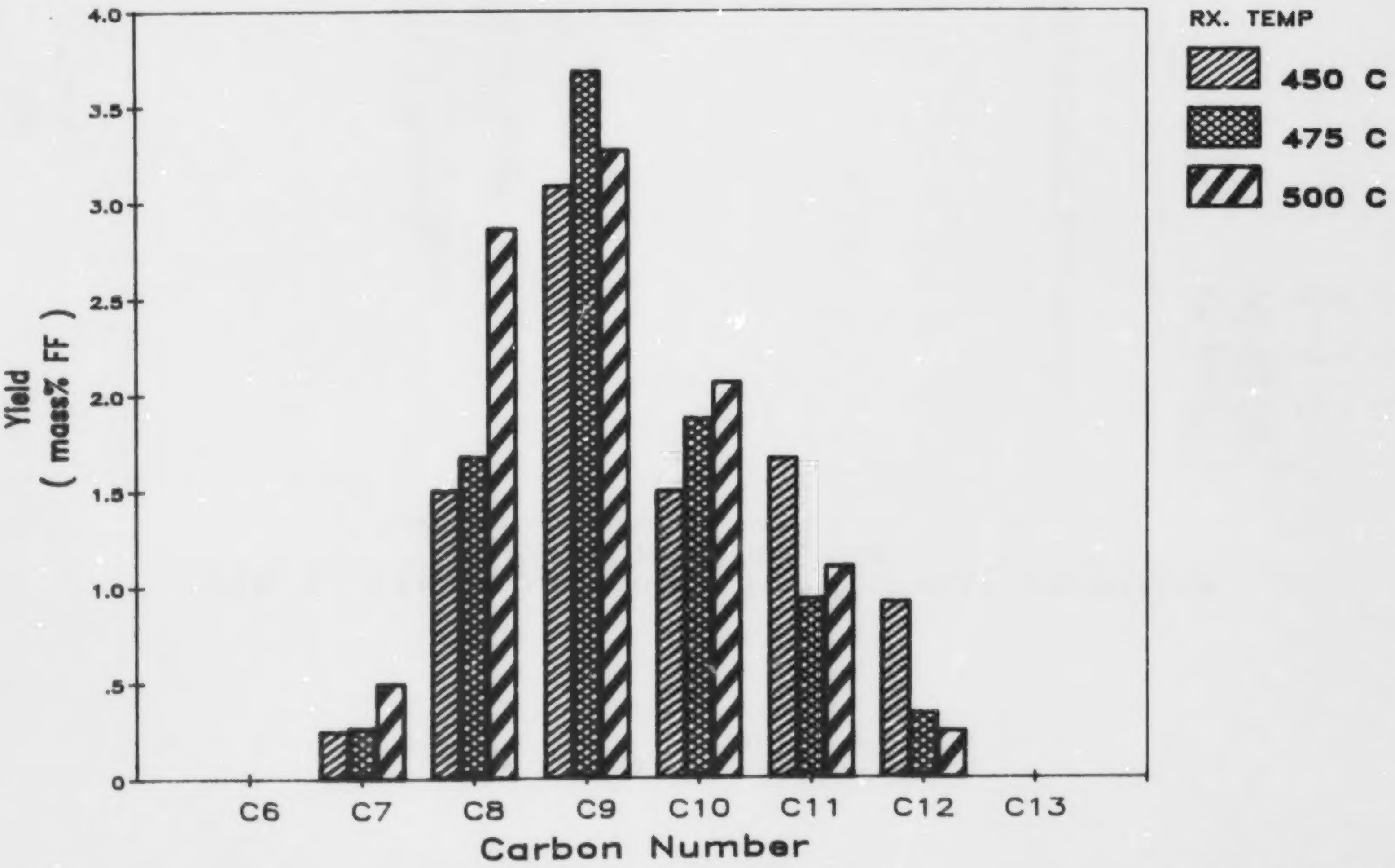


T1P6C18

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Octadecane WHSV (1/h) : 15





Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

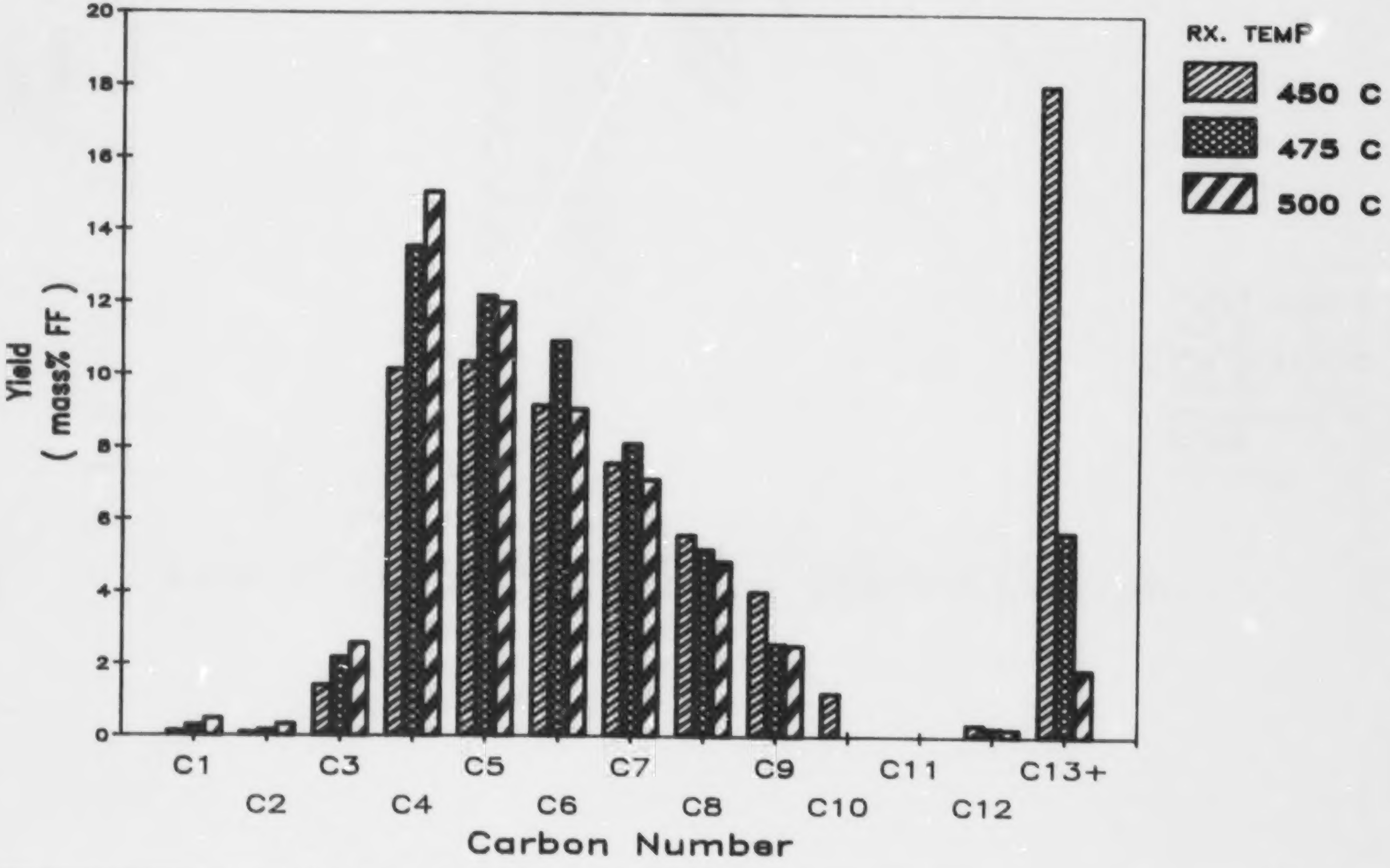
Feed : Octadecane WHSV (1/h) : 15

T1A6C18

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

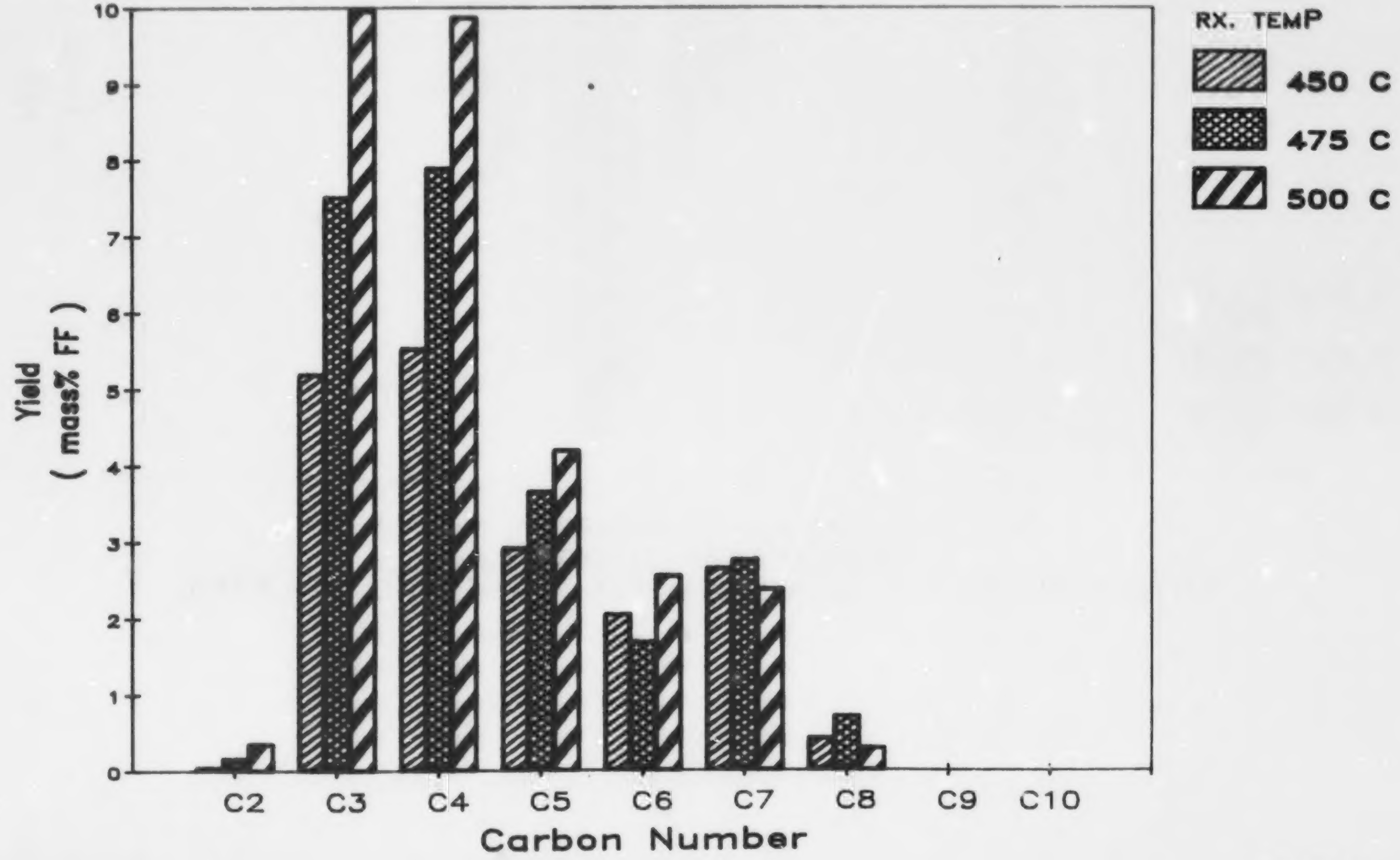
Feed : Octadecane WHSV (1/h) : 9



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Octadecane WHSV (1/h) : 9

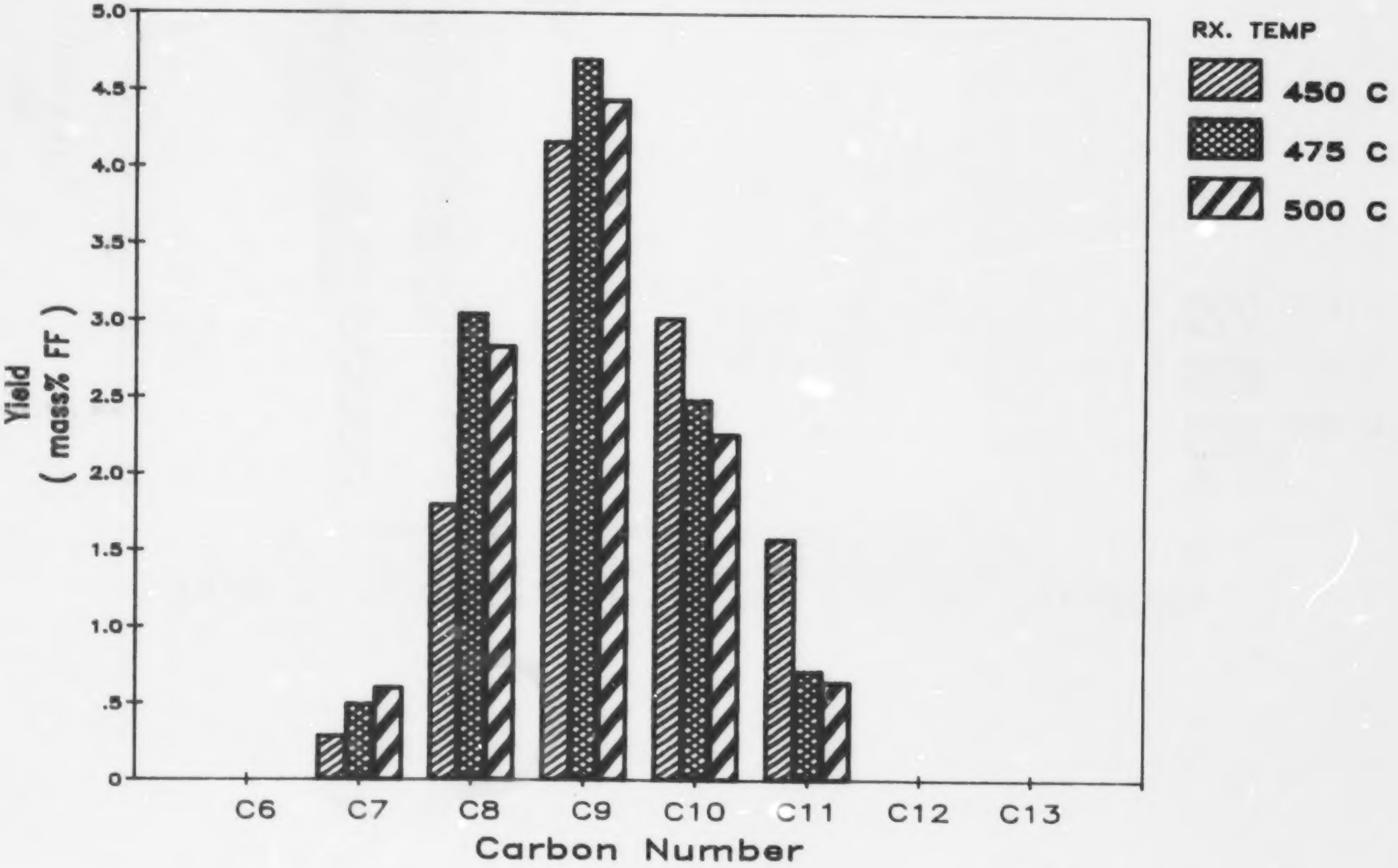


T101C18

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Octadecane WHSV (1/h) : 9

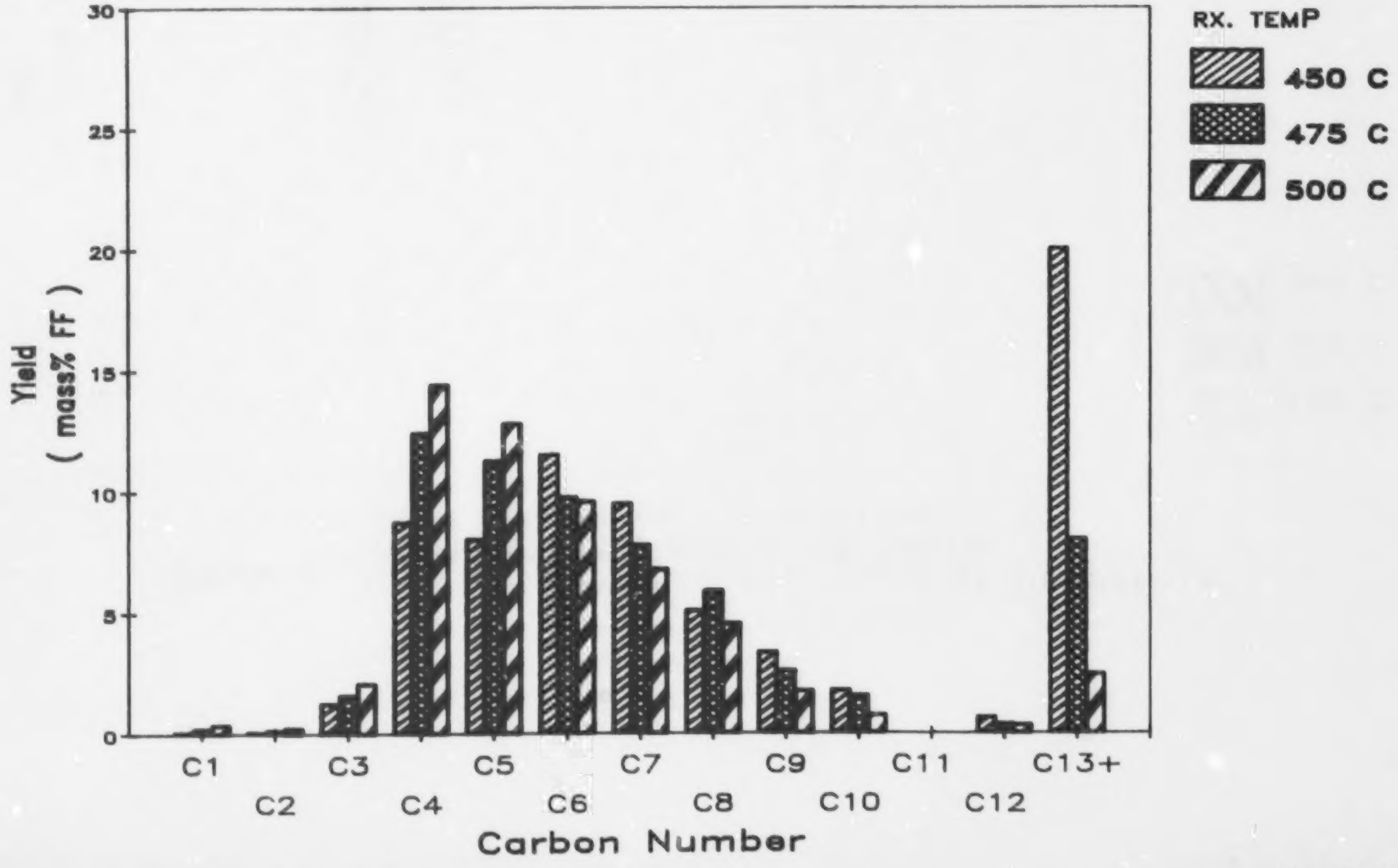


T1A1C18

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

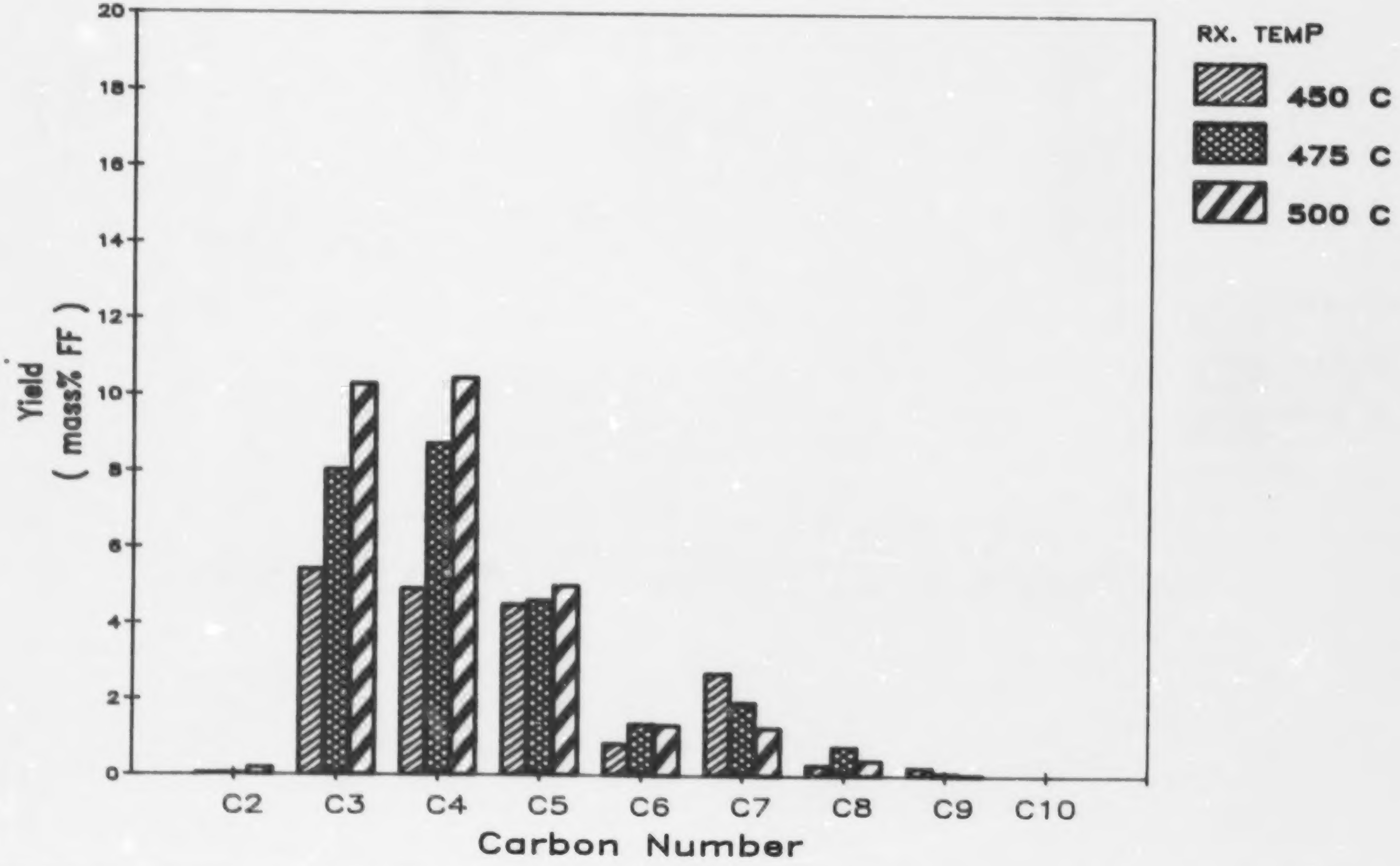
Feed : Octadecane   WHSV (1/h) : 4.5



T1P2C18

Task 1. Cracking Yields for Normal Paraffins

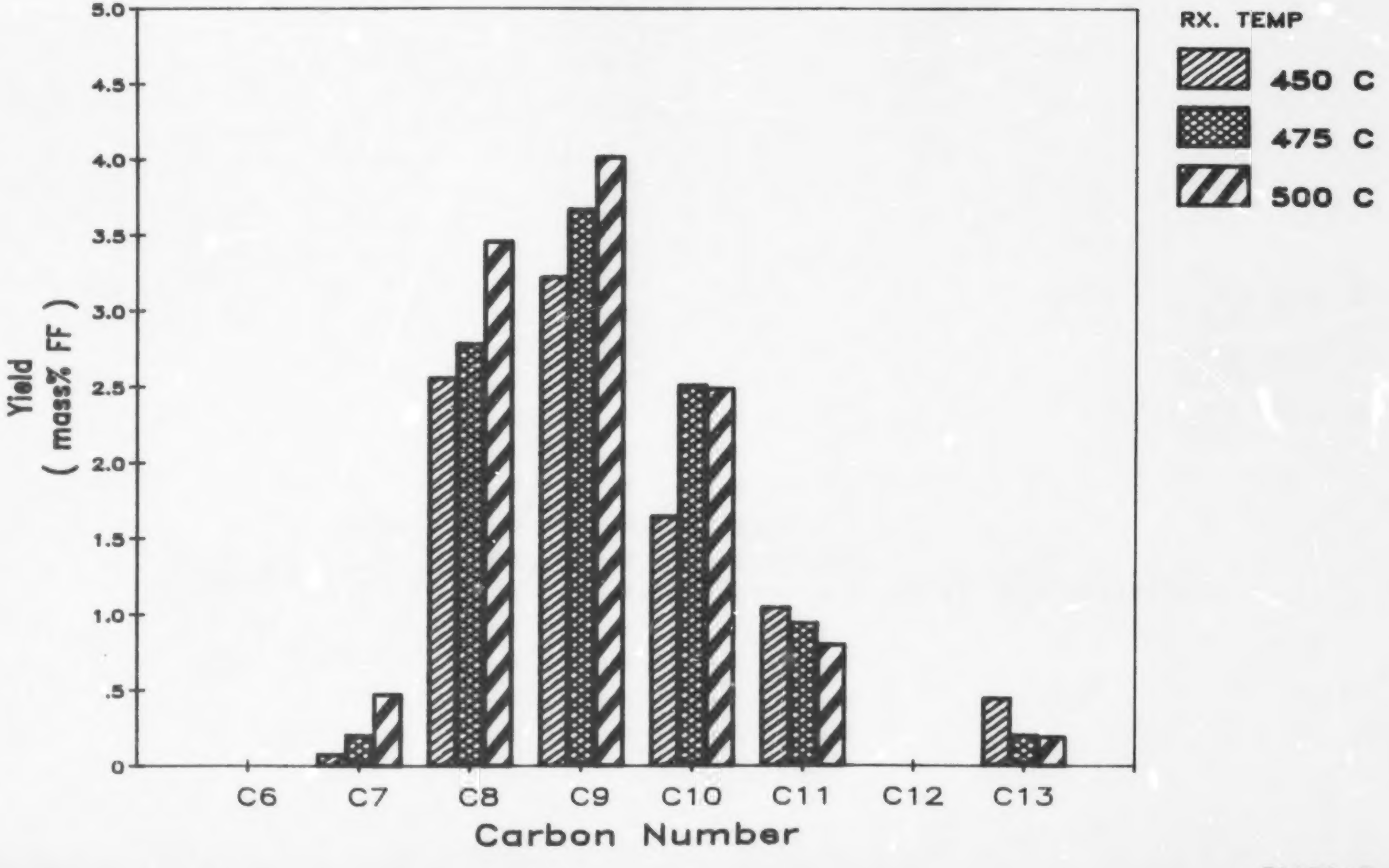
OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Octadecane WHSV (1/h) : 4.5



Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Octadecane WHSV (1/h) : 4.5

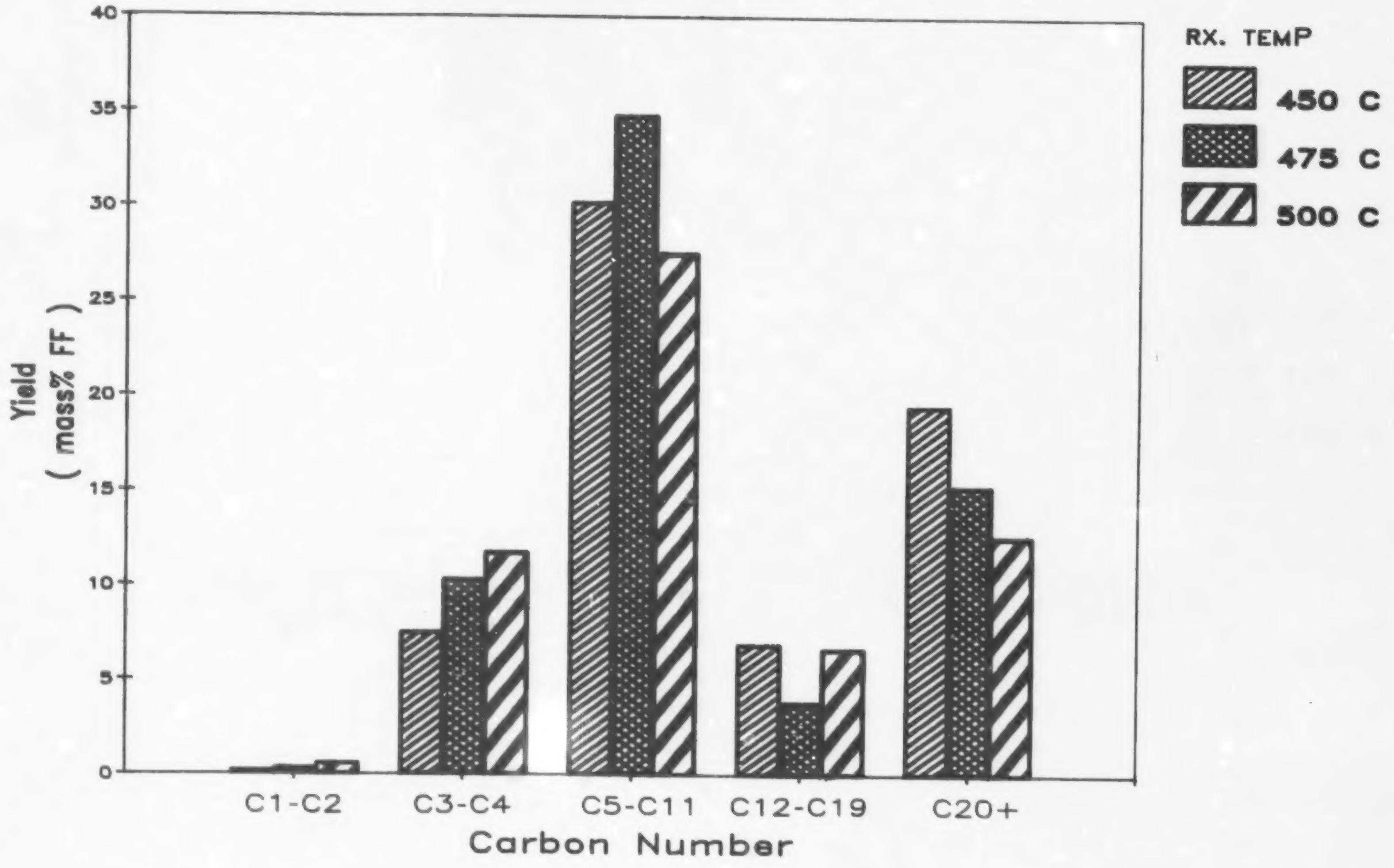


T1A2C18

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

Feed : Hexacosane WHSV (1/h) : 15

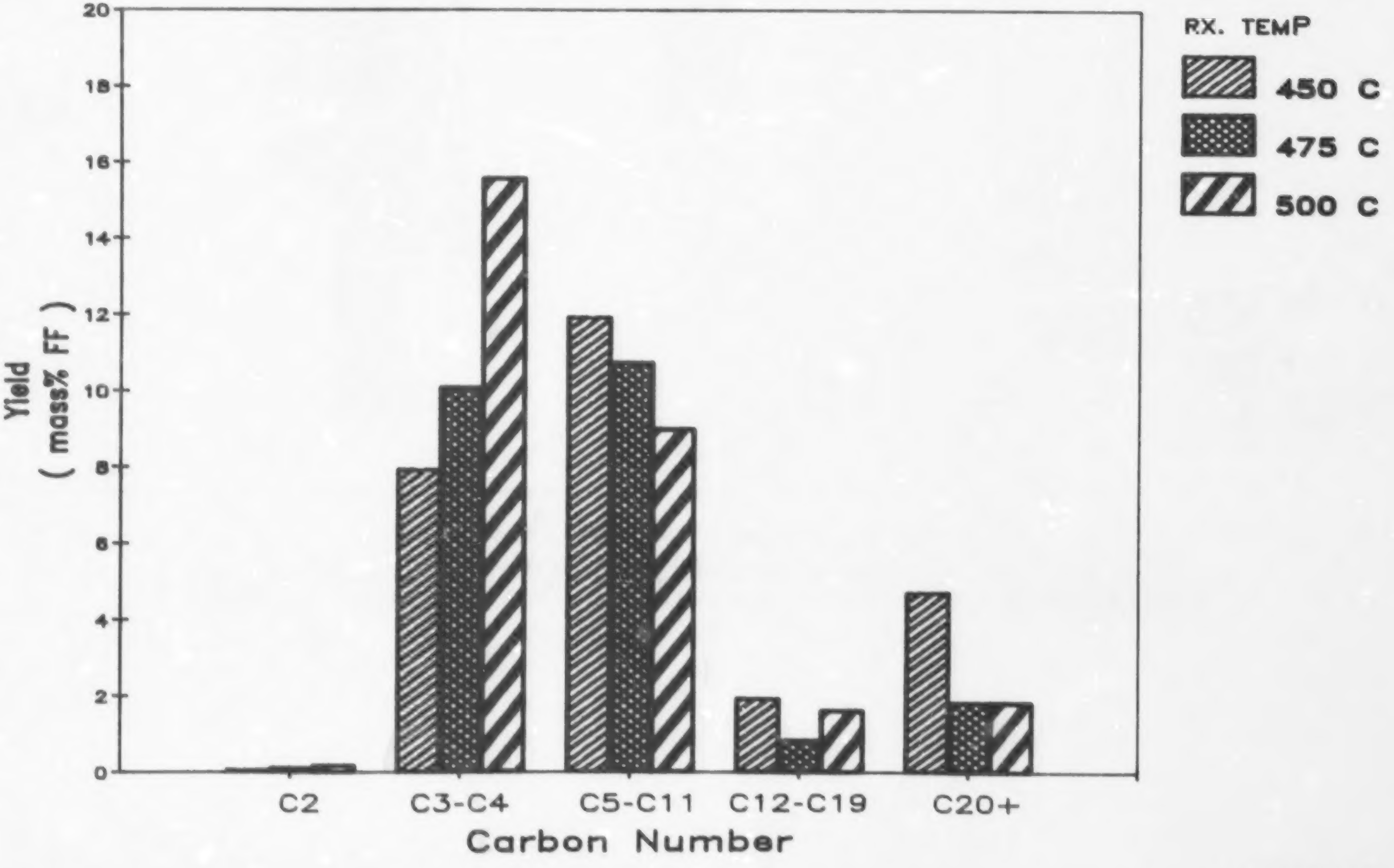


T1BP6C26

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Hexacosane WHSV (1/h) : 15

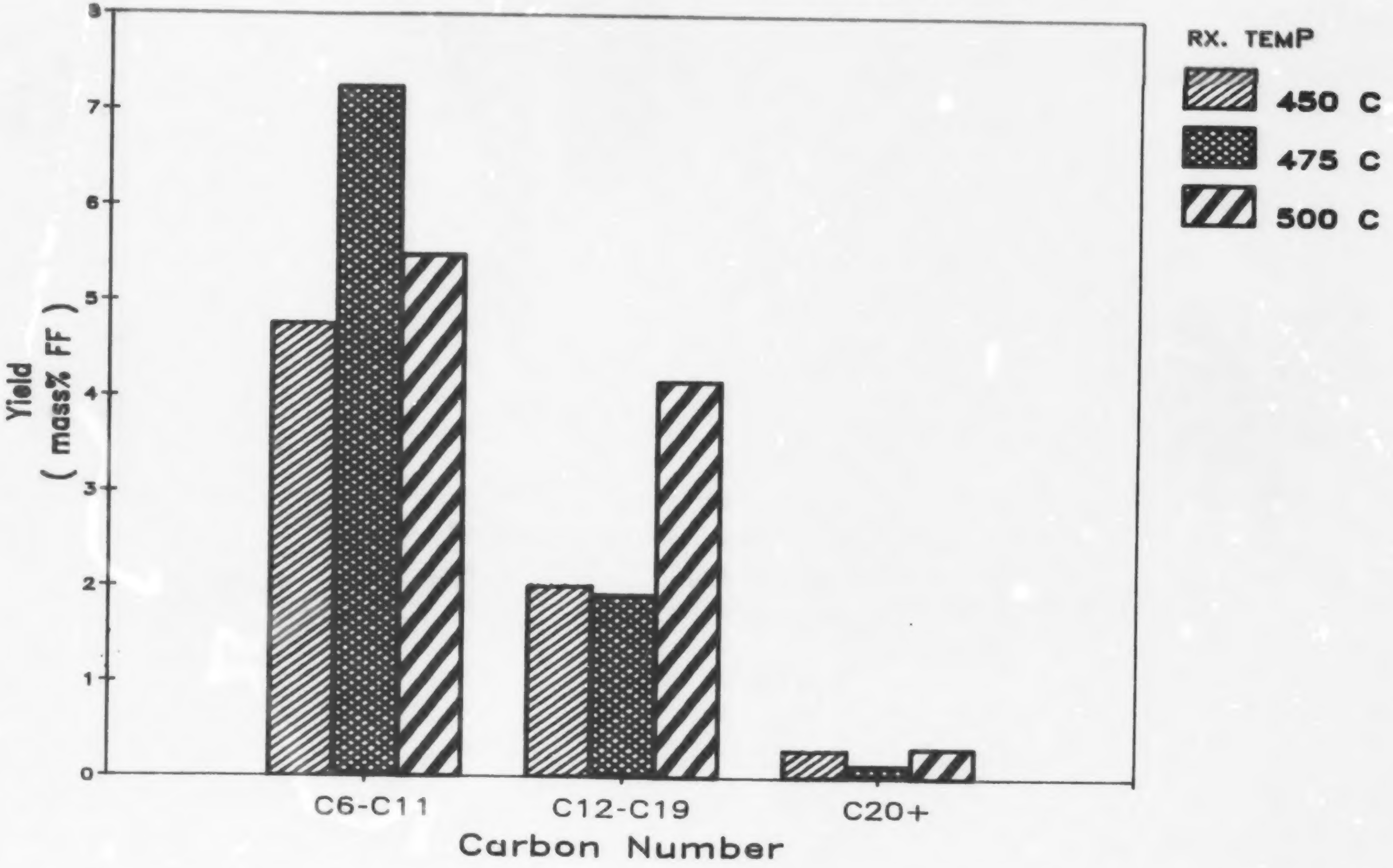


T1B06C26

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Hexacosane   WHSV (1/h) : 15

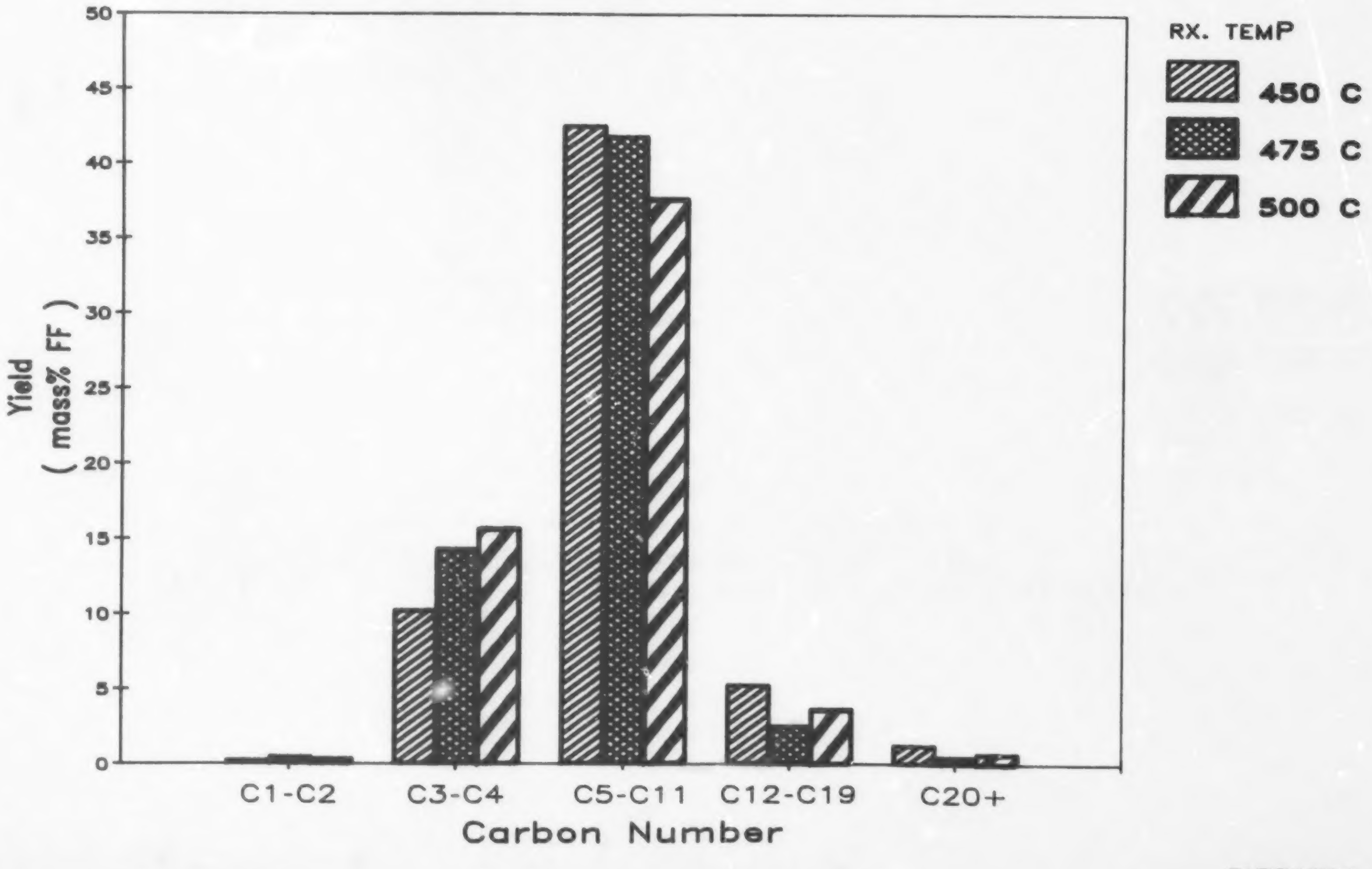


T1BA6C26

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

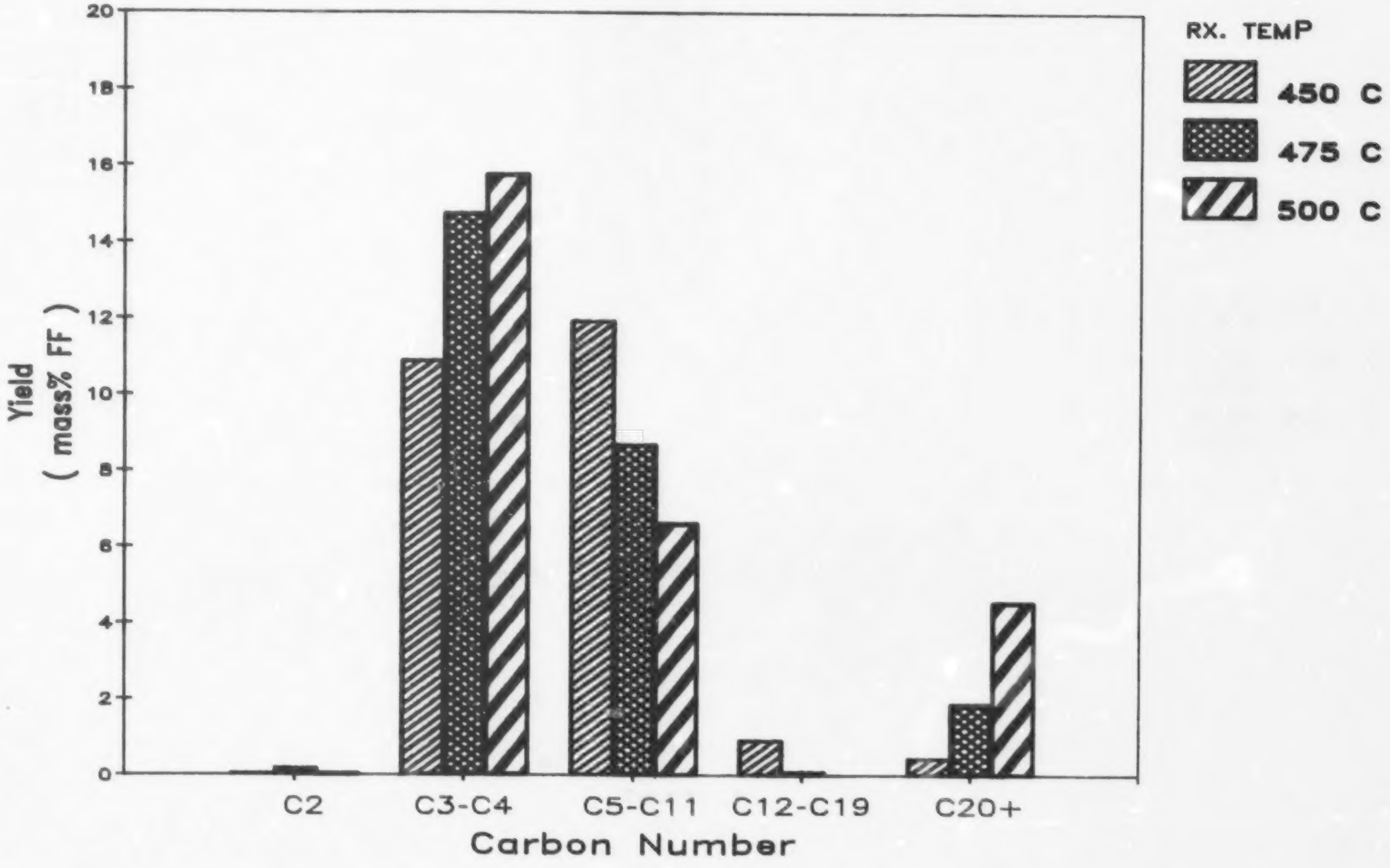
Feed : Hexacosane WHSV (1/h) : 9



T1BP1C26

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Hexacosane WHSV (1/h) : 9

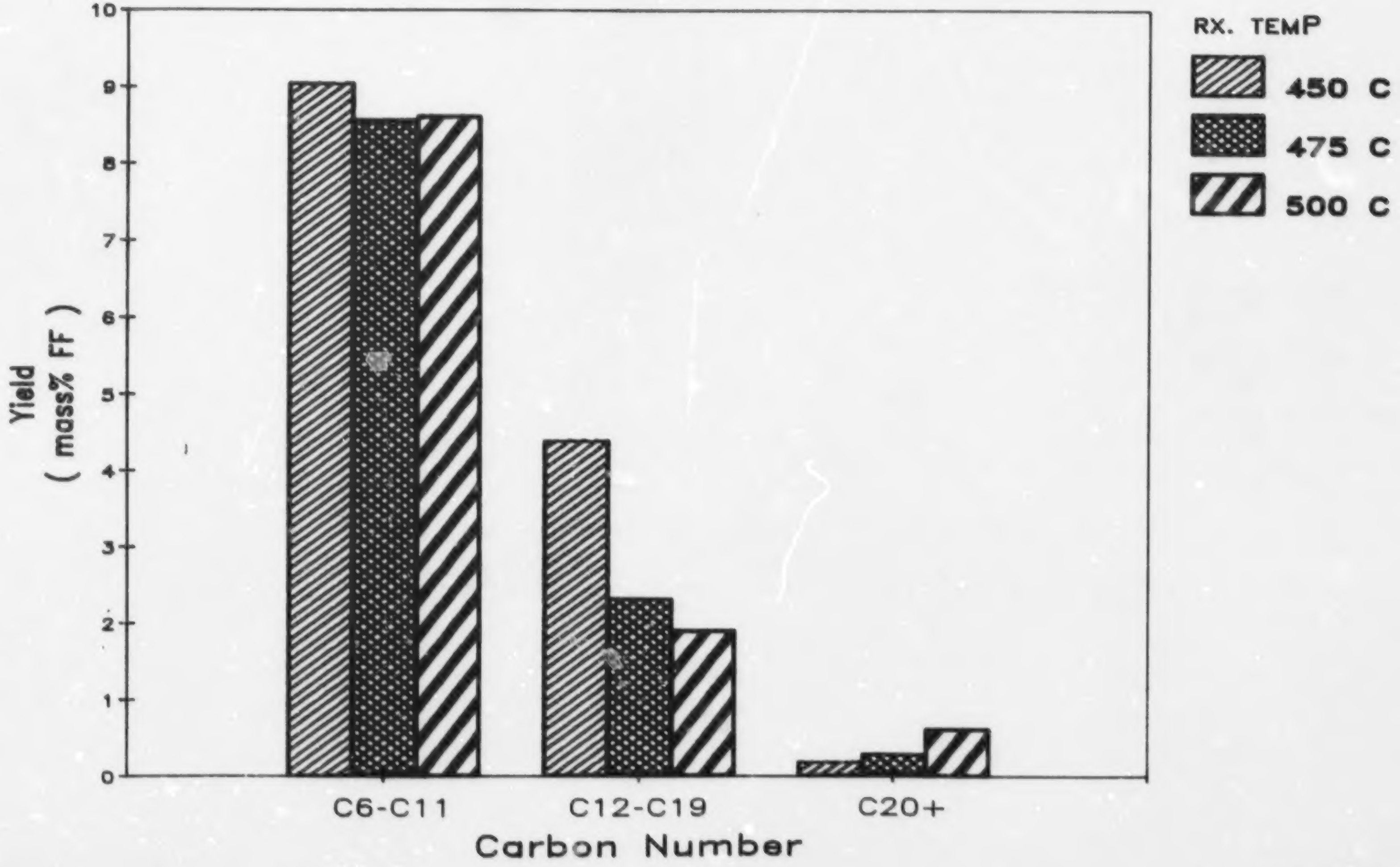


T1B01C26

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Hexacosane WHSV (1/h) : 9

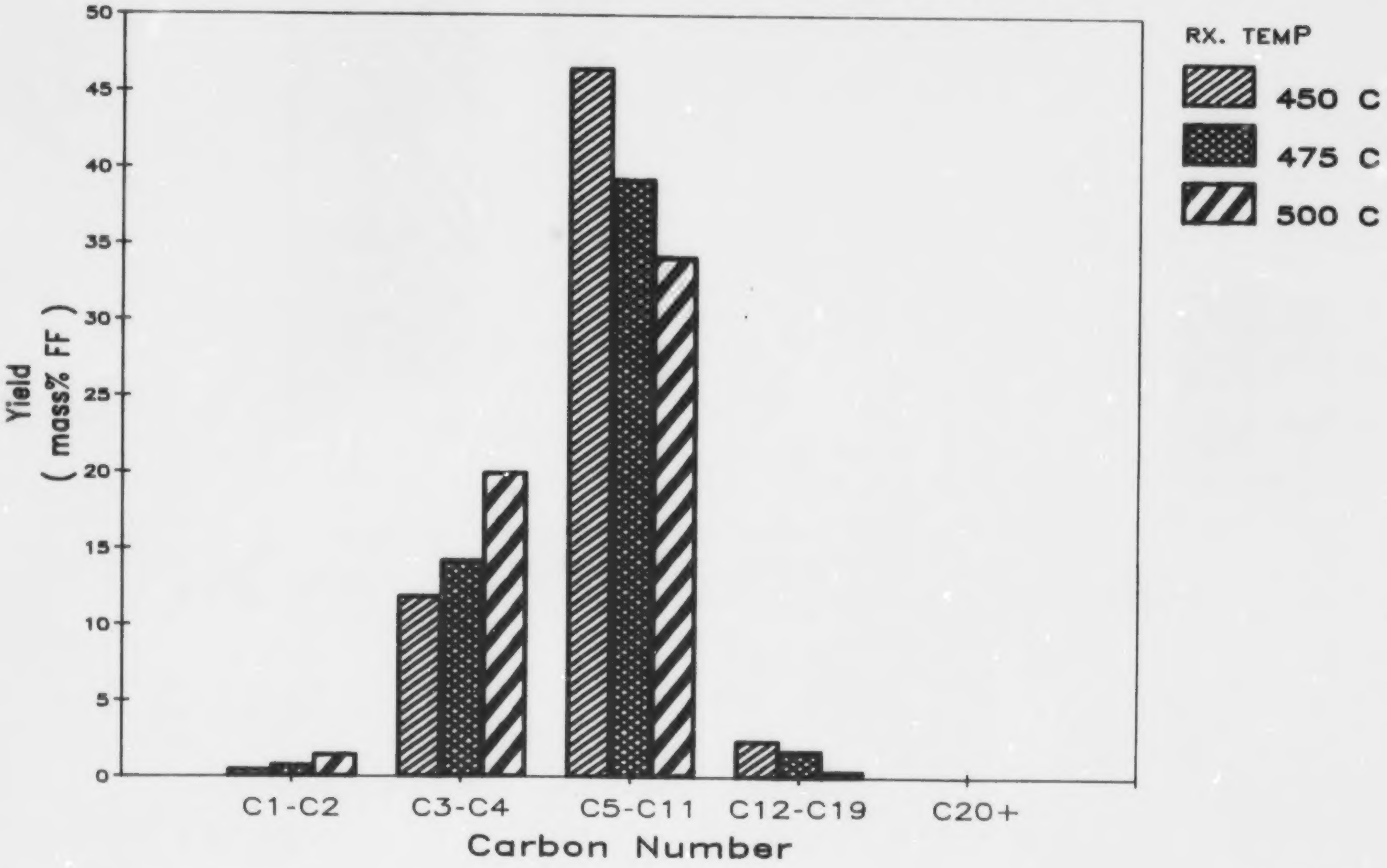


T1BA1C26

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

Feed : Hexacosane WHSV (1/h) : 4.5

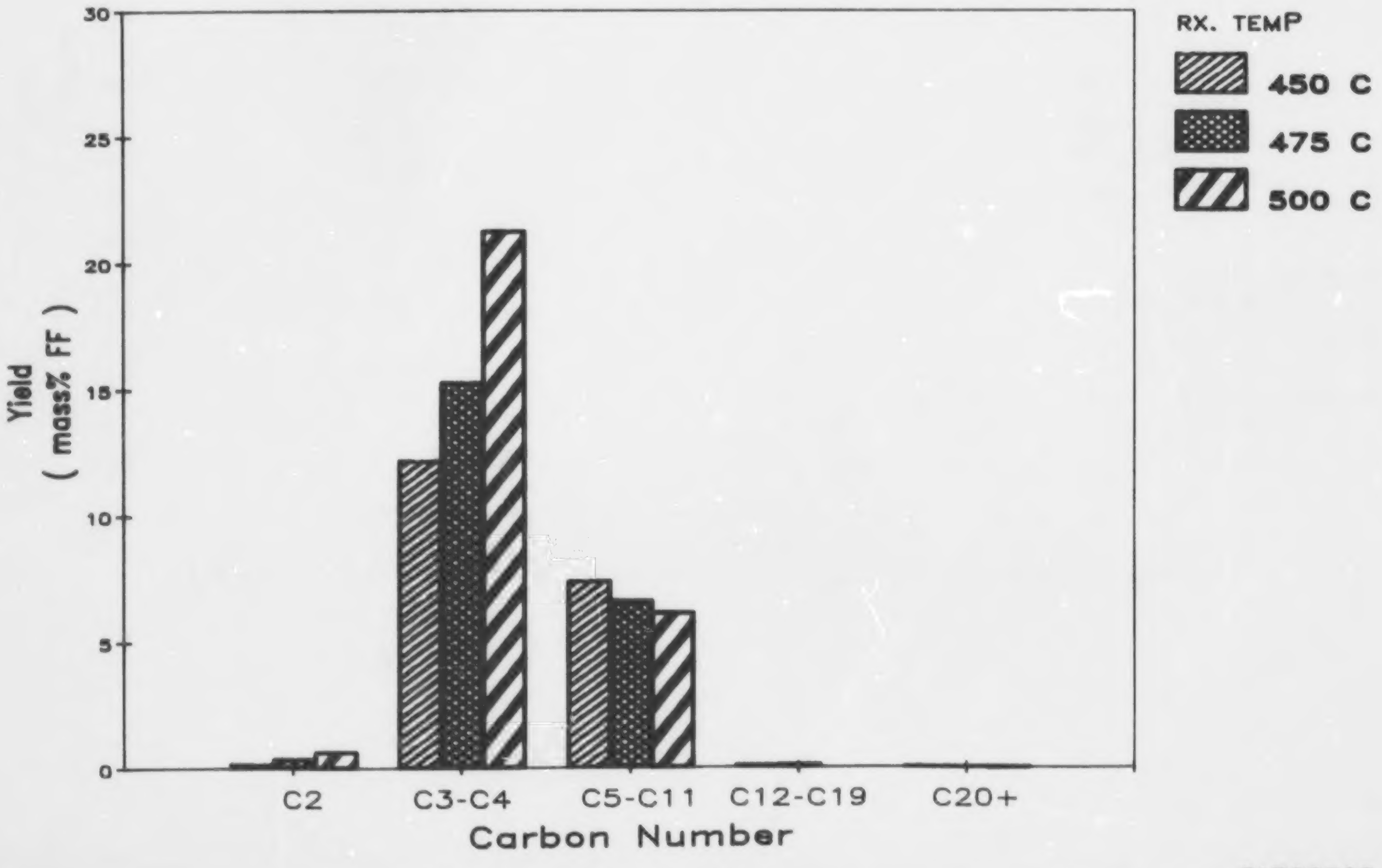


T1BP2C26

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Hexacosane WHSV (1/h) : 4.5

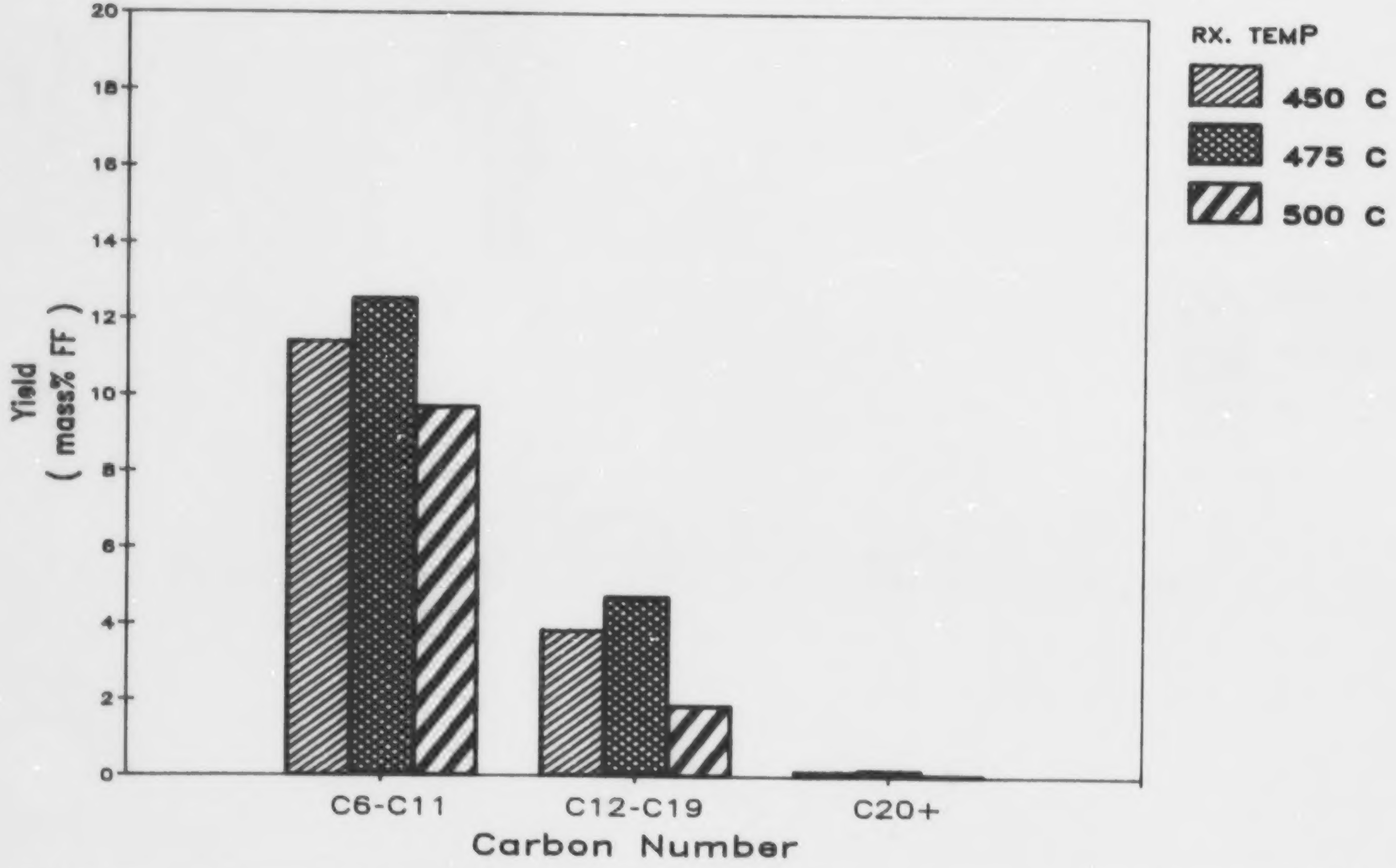


T1B02C26

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

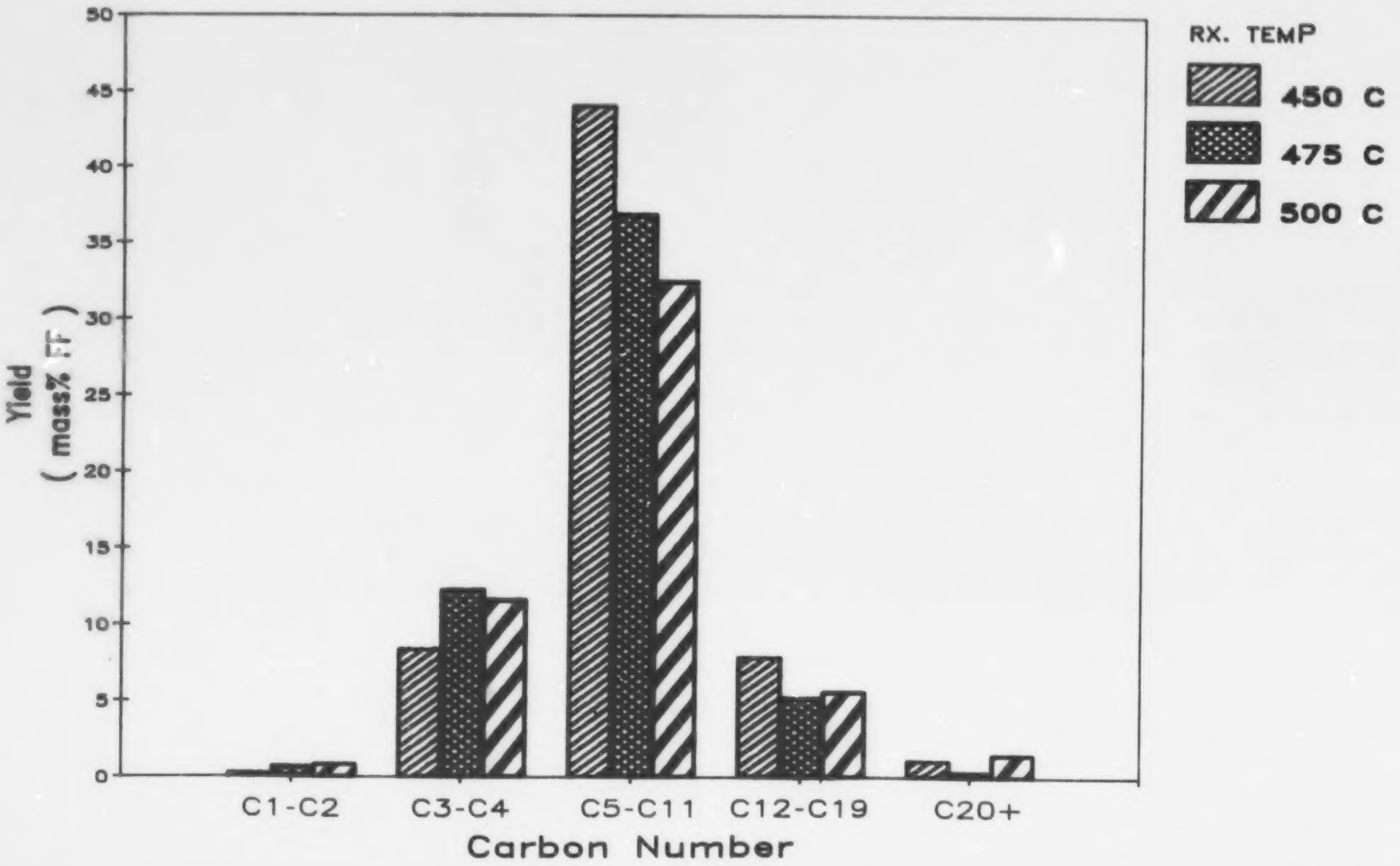
Feed : Hexacosane WHSV (1/h) : 4.5



Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

Feed : Dotriacontane WHSV (1/h) : 15

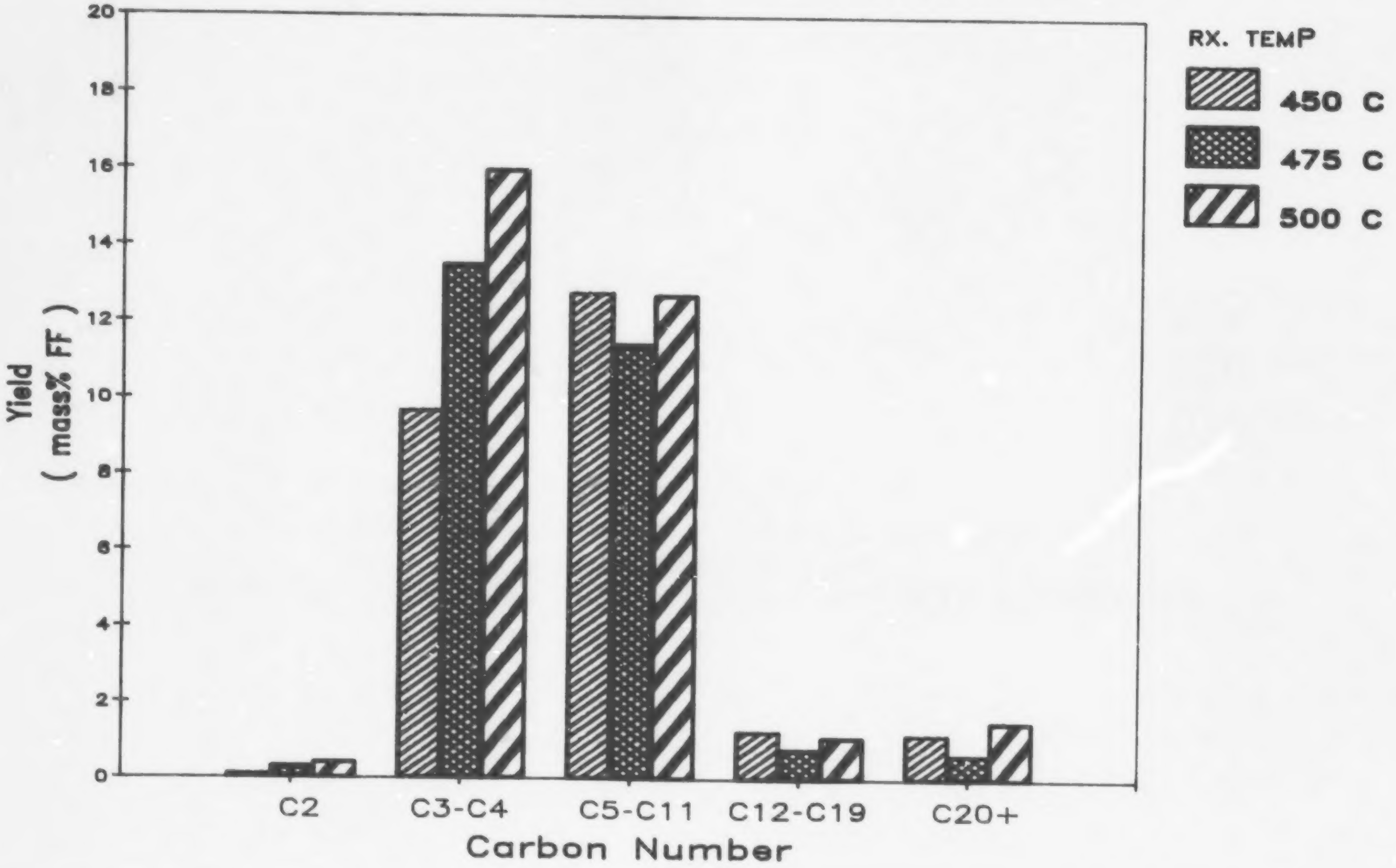


T1BP6C32

Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Dotriacontane WHSV (1/h) : 15

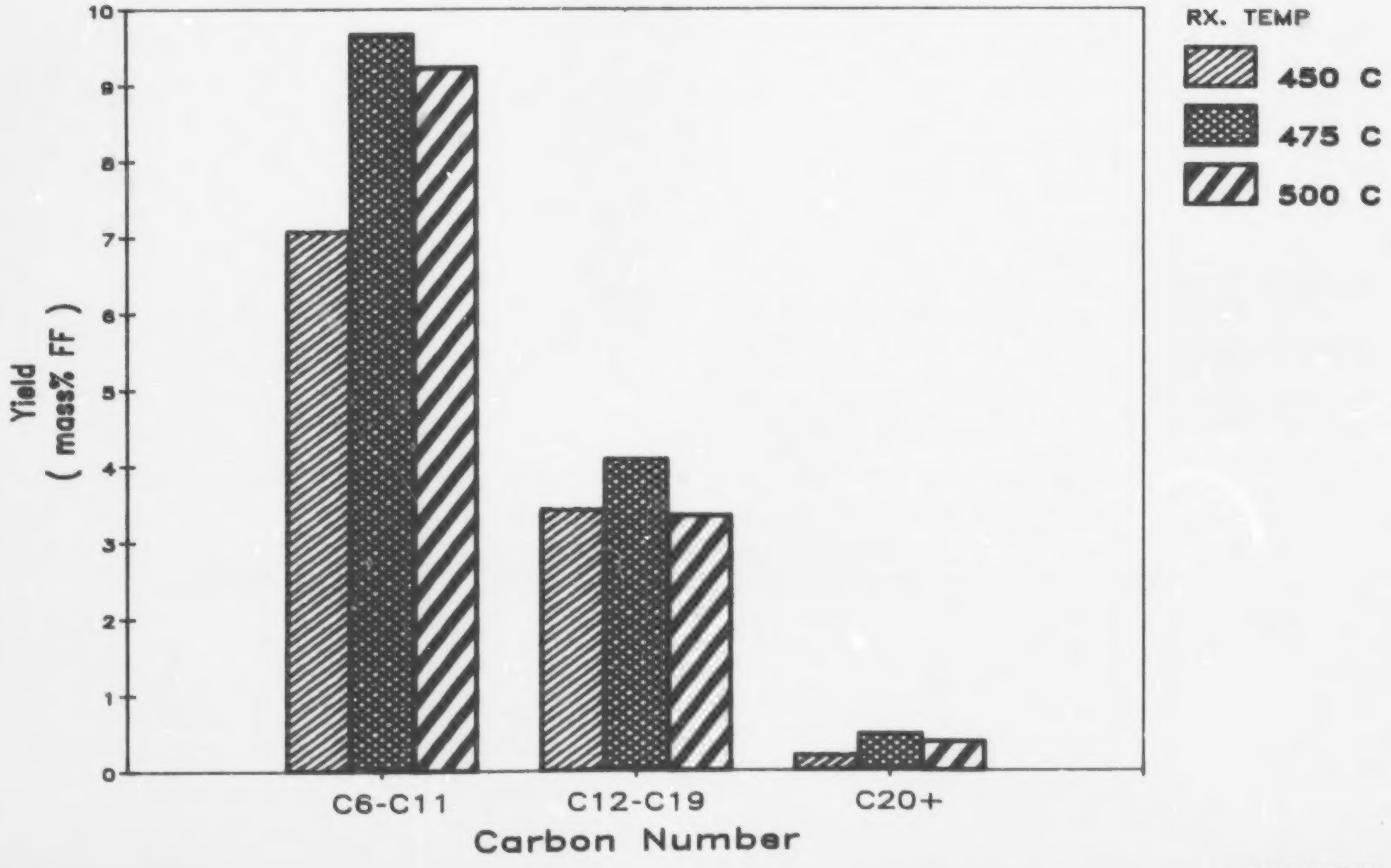


T1B06C32

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

Feed : Dotriacontane WHSV (1/h) : 15

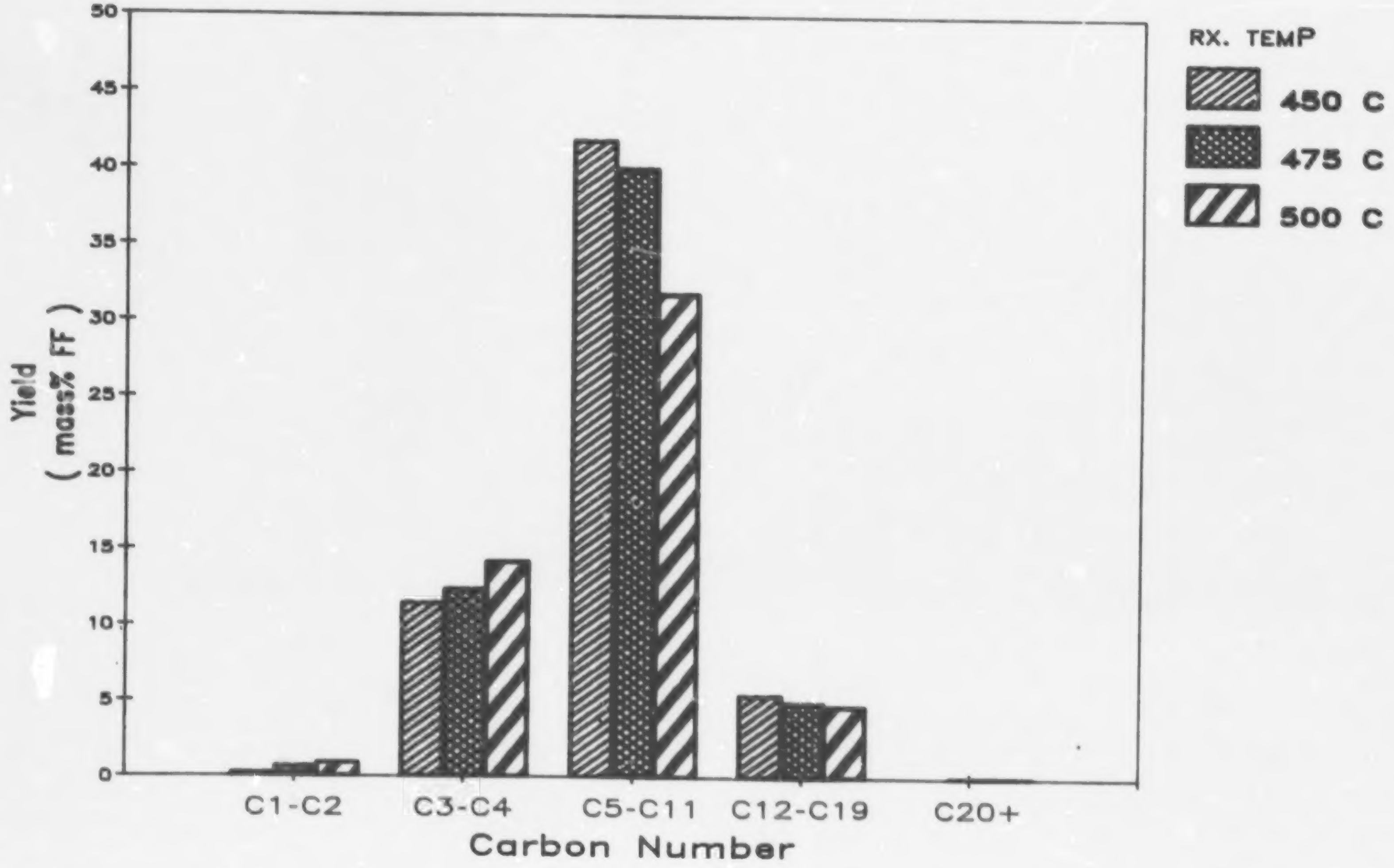


T1BA6C32

Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

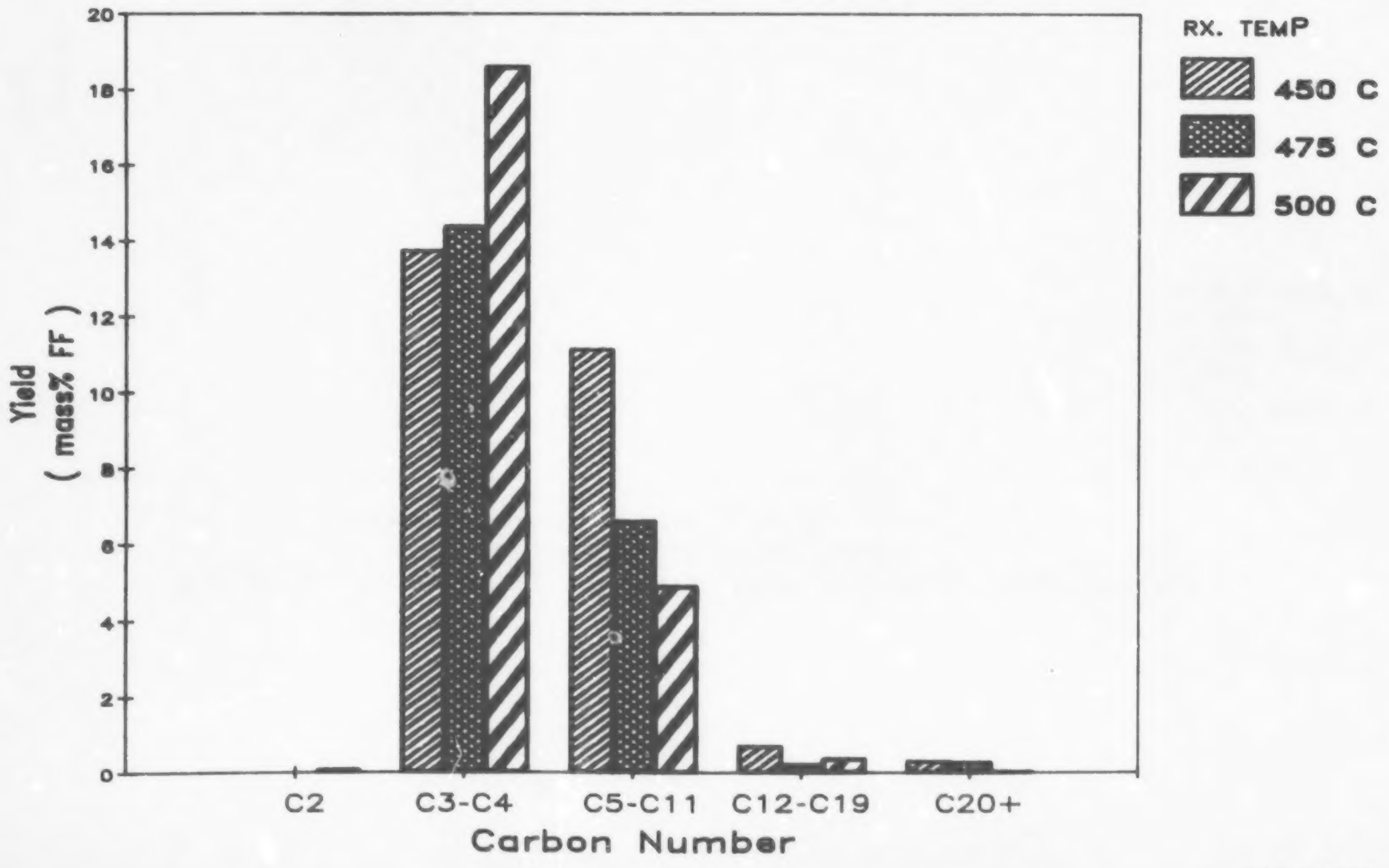
Feed : Dotriacontane WHSV (1/h) : 9



Task 1. Cracking Yields for Normal Paraffins

OLEFIN & CYCLO-OLEFIN DISTRIBUTION

Feed : Dotriacontane WHSV (1/h) : 9

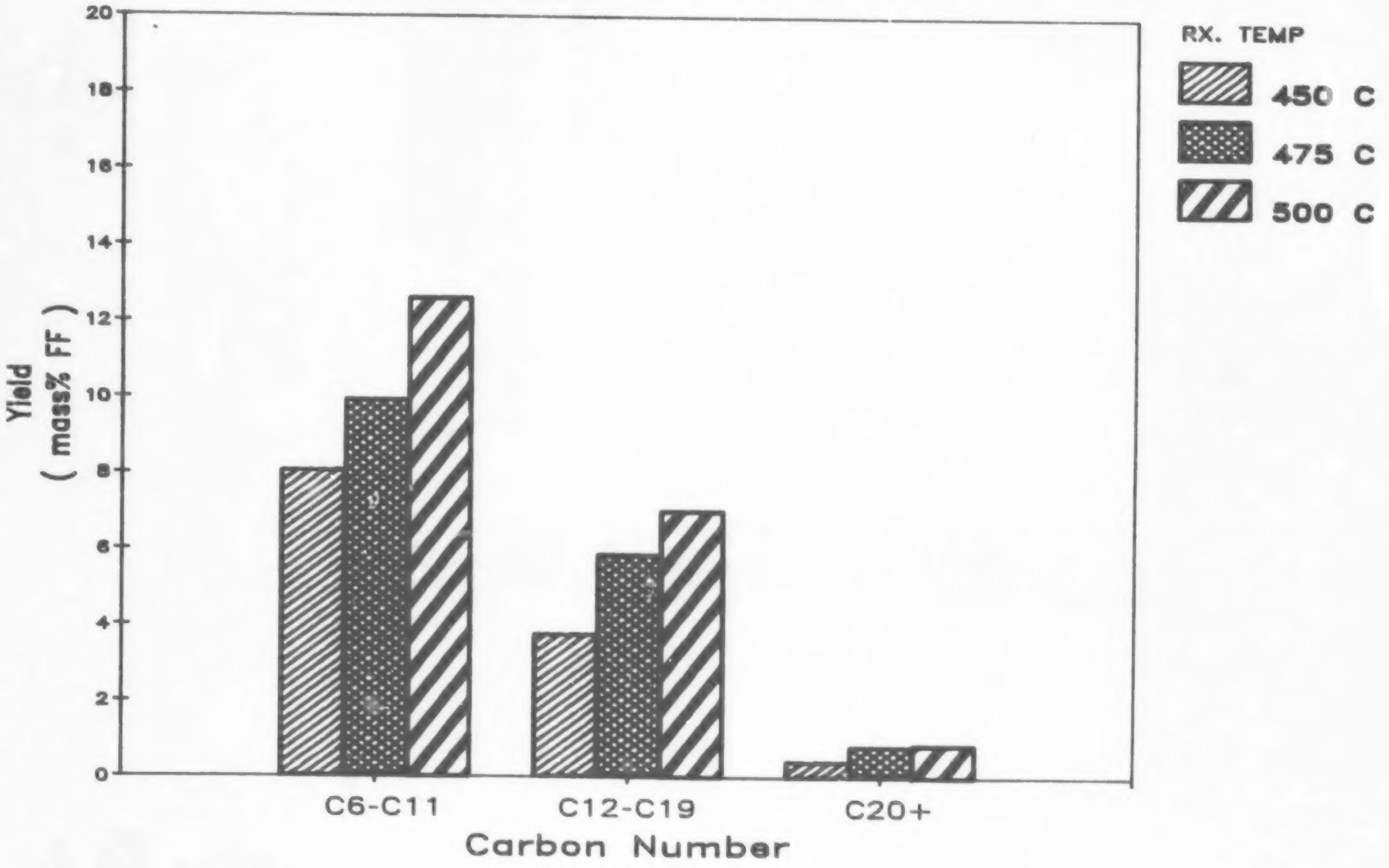


T1B01C32

Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

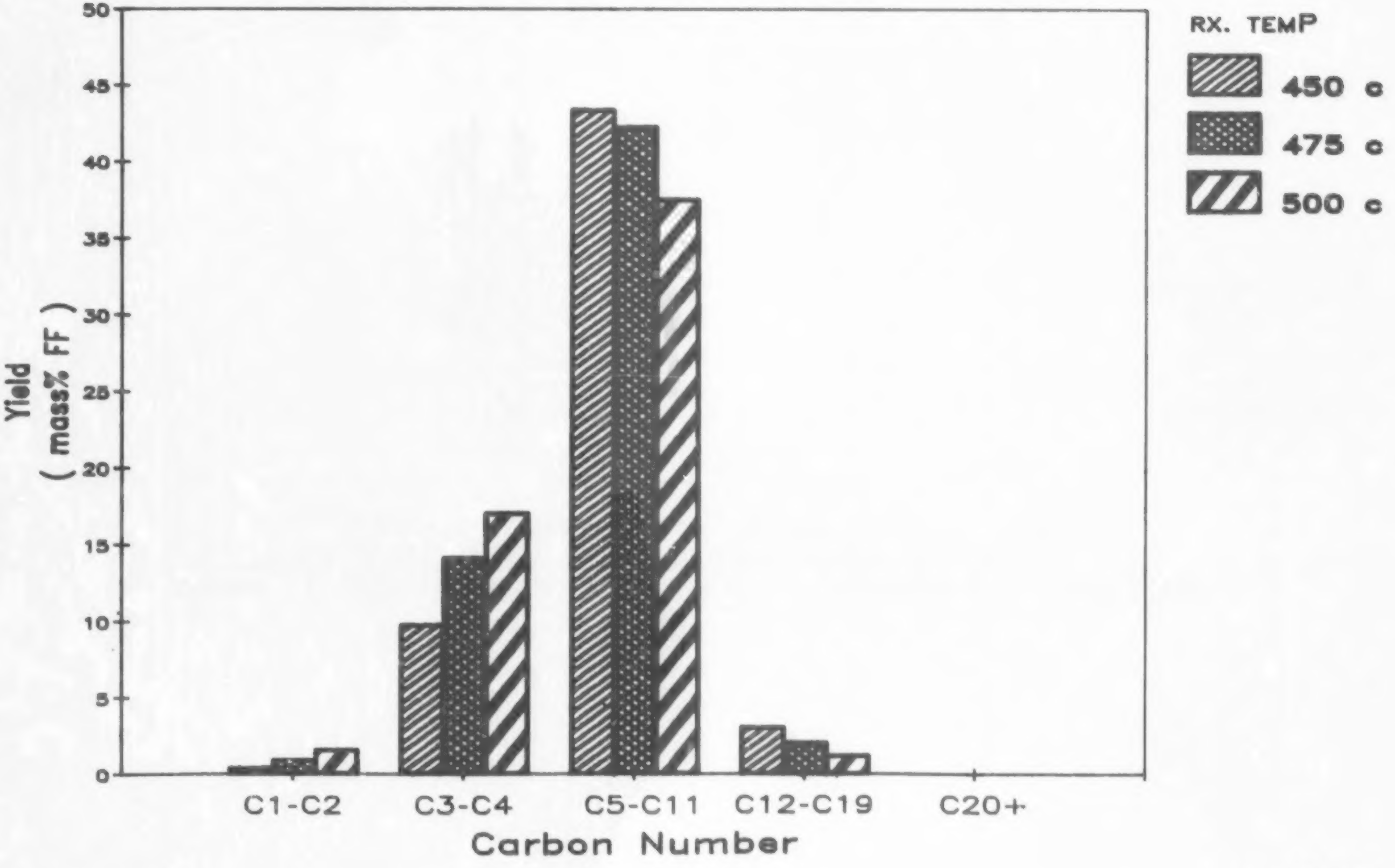
Feed : Dotriacontane WHSV (1/h) : 9



Task 1. Cracking Yields for Normal Paraffins

PARAFFIN DISTRIBUTION

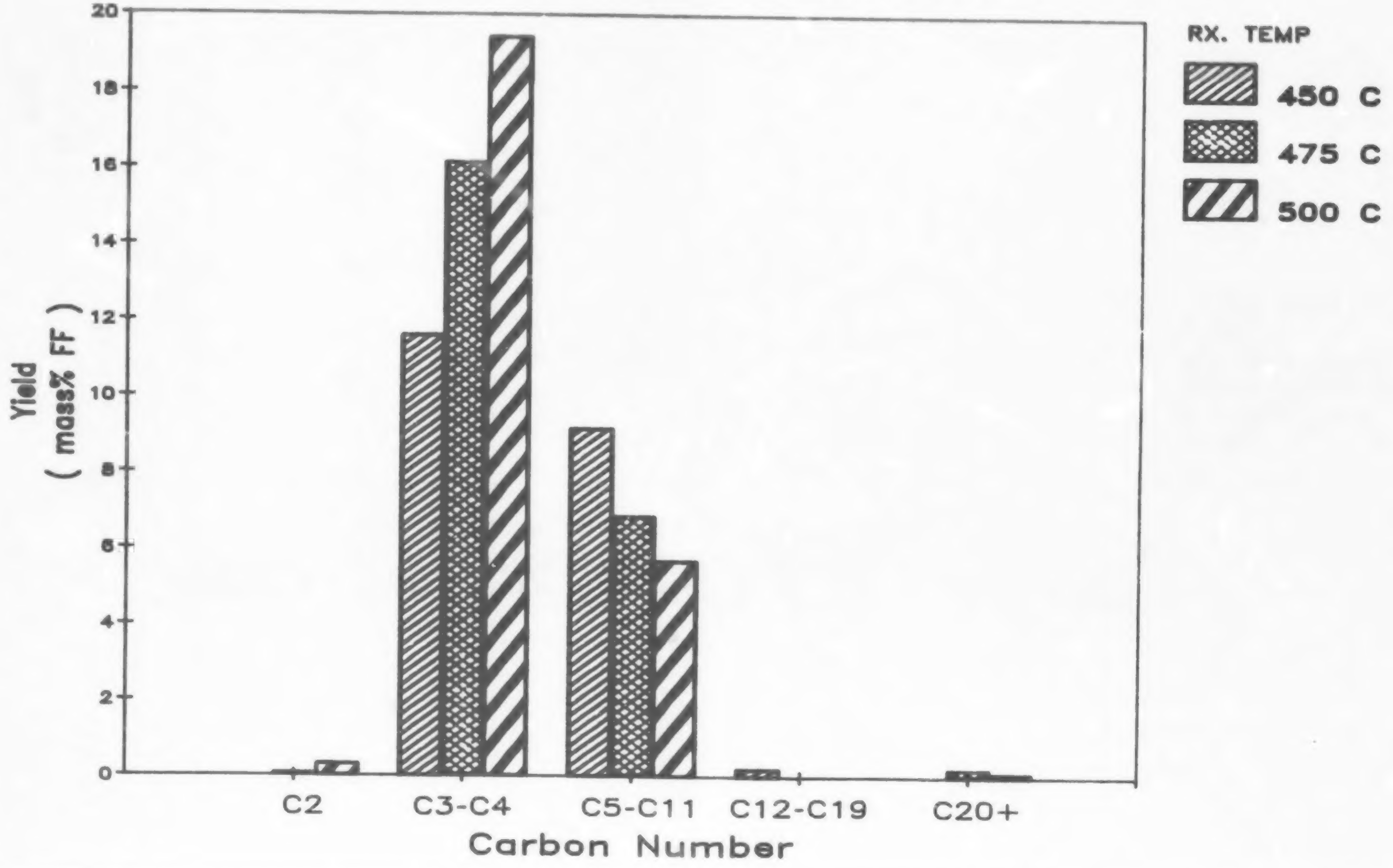
Feed : Dotriacontane   WHSV (1/h) : 4.5



T1BP2C32

Task 1. Cracking Yields for Normal Paraffins

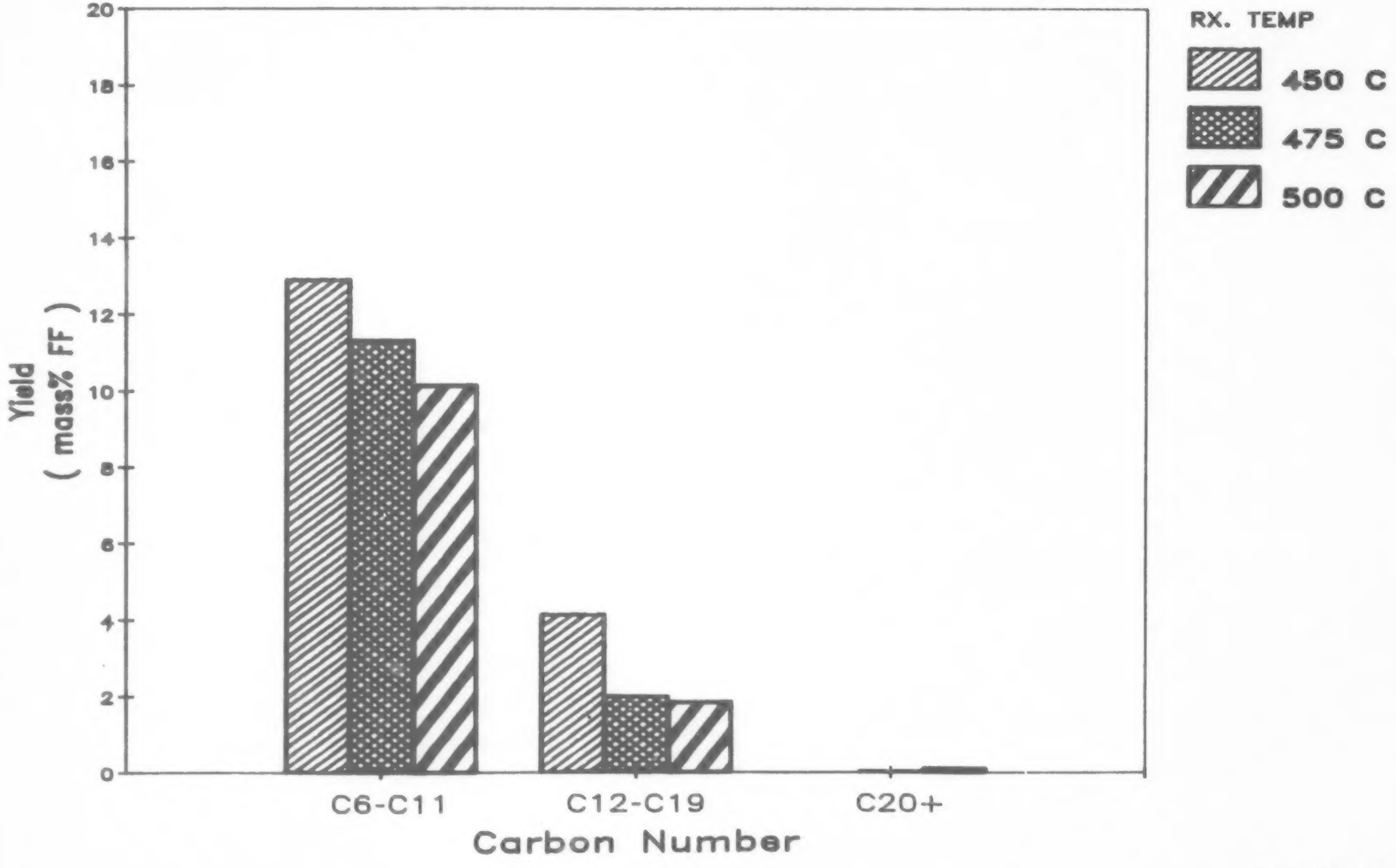
OLEFIN & CYCLO-OLEFIN DISTRIBUTION
Feed : Dotriacontane WHSV (1/h) : 4.5



Task 1. Cracking Yields for Normal Paraffins

AROMATIC DISTRIBUTION

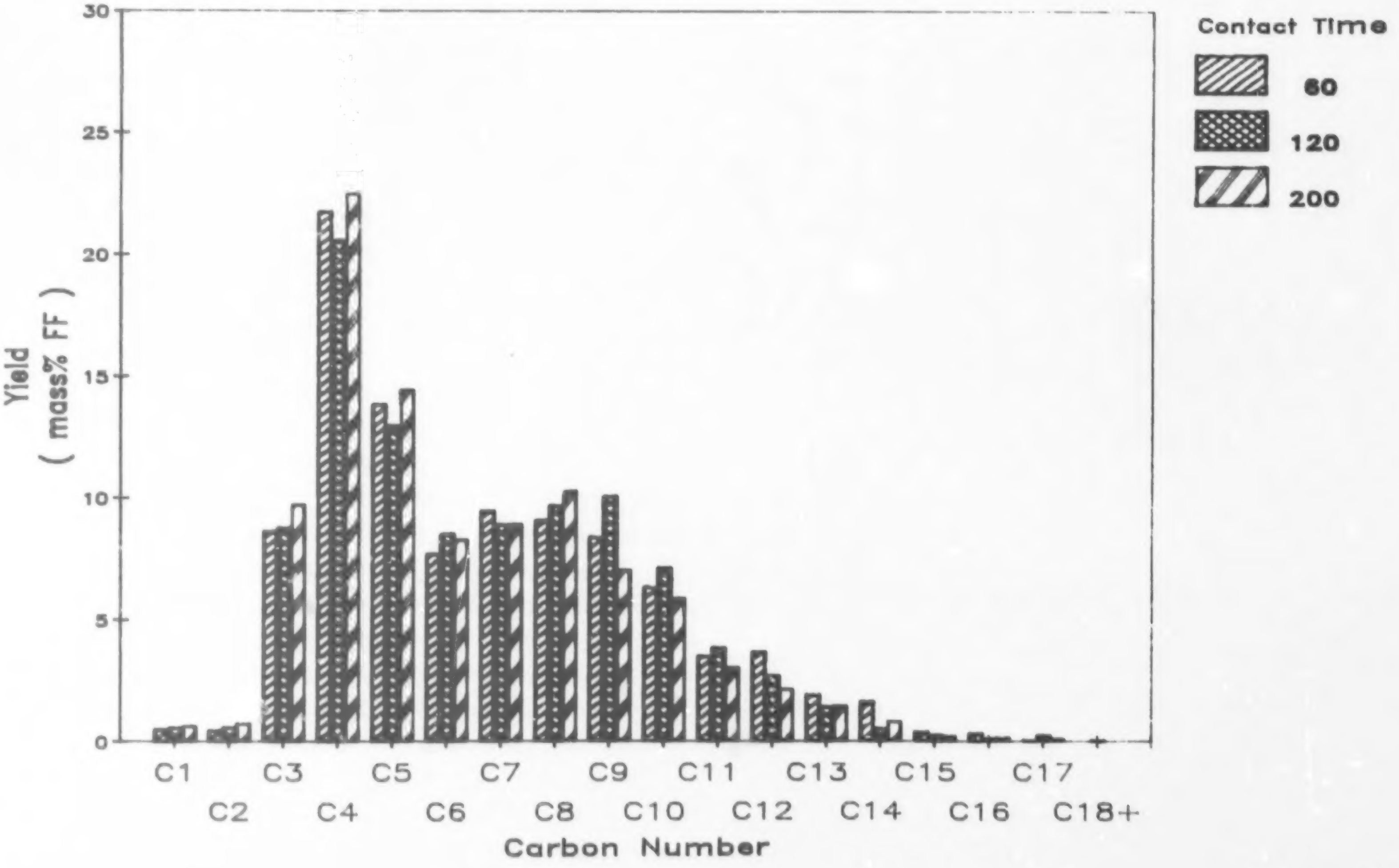
Feed : Dotriacontane WHSV (1/h) : 4.5



T1BA2C32

Task 2. Cracking Yields for other Hydrocarbons

REACTOR EFFLUENT CARBON DISTRIBUTION
2,6,10,14-Tetramethylpentadecane



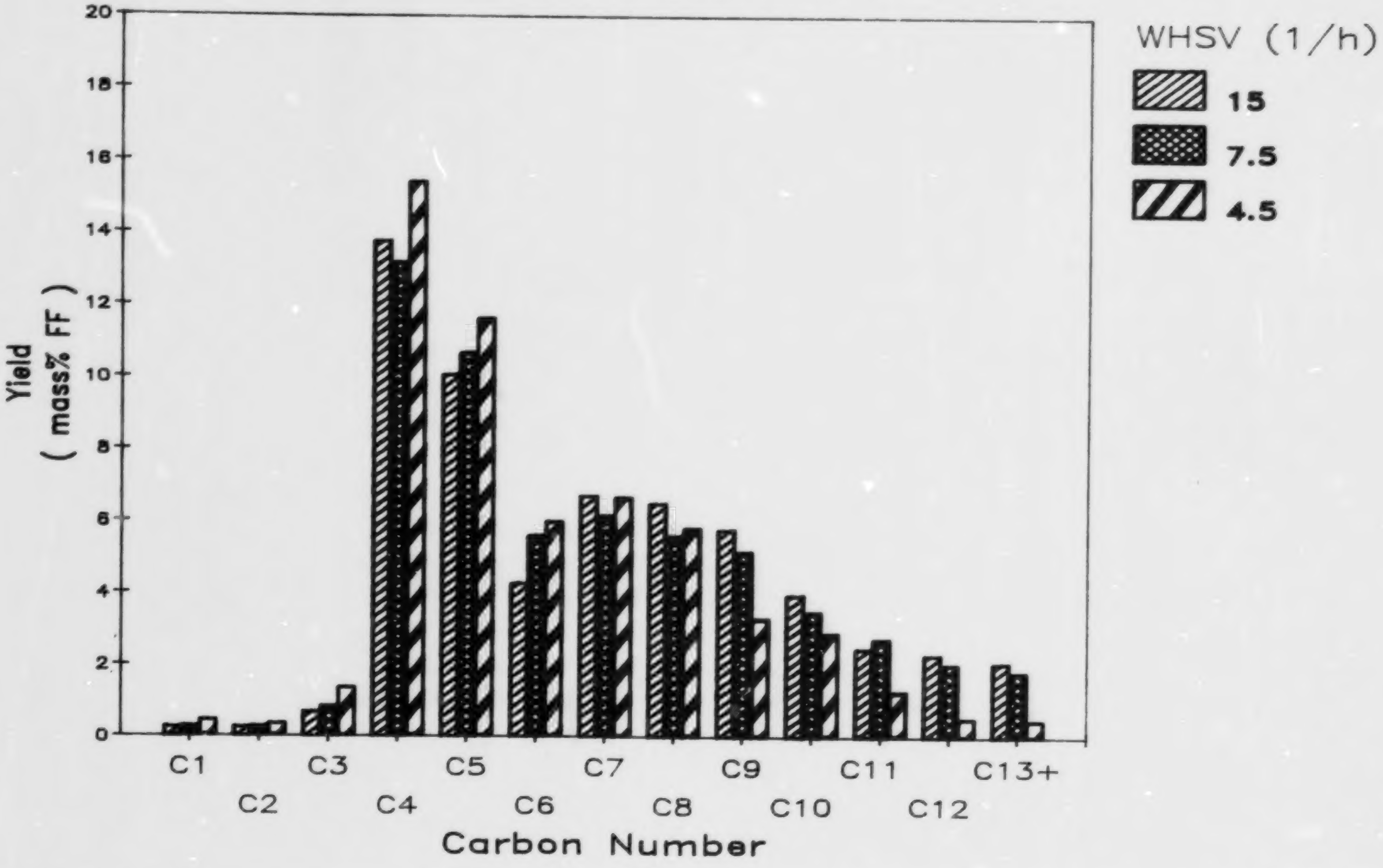
X

T2TMPDCD

Task 2. Cradking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION

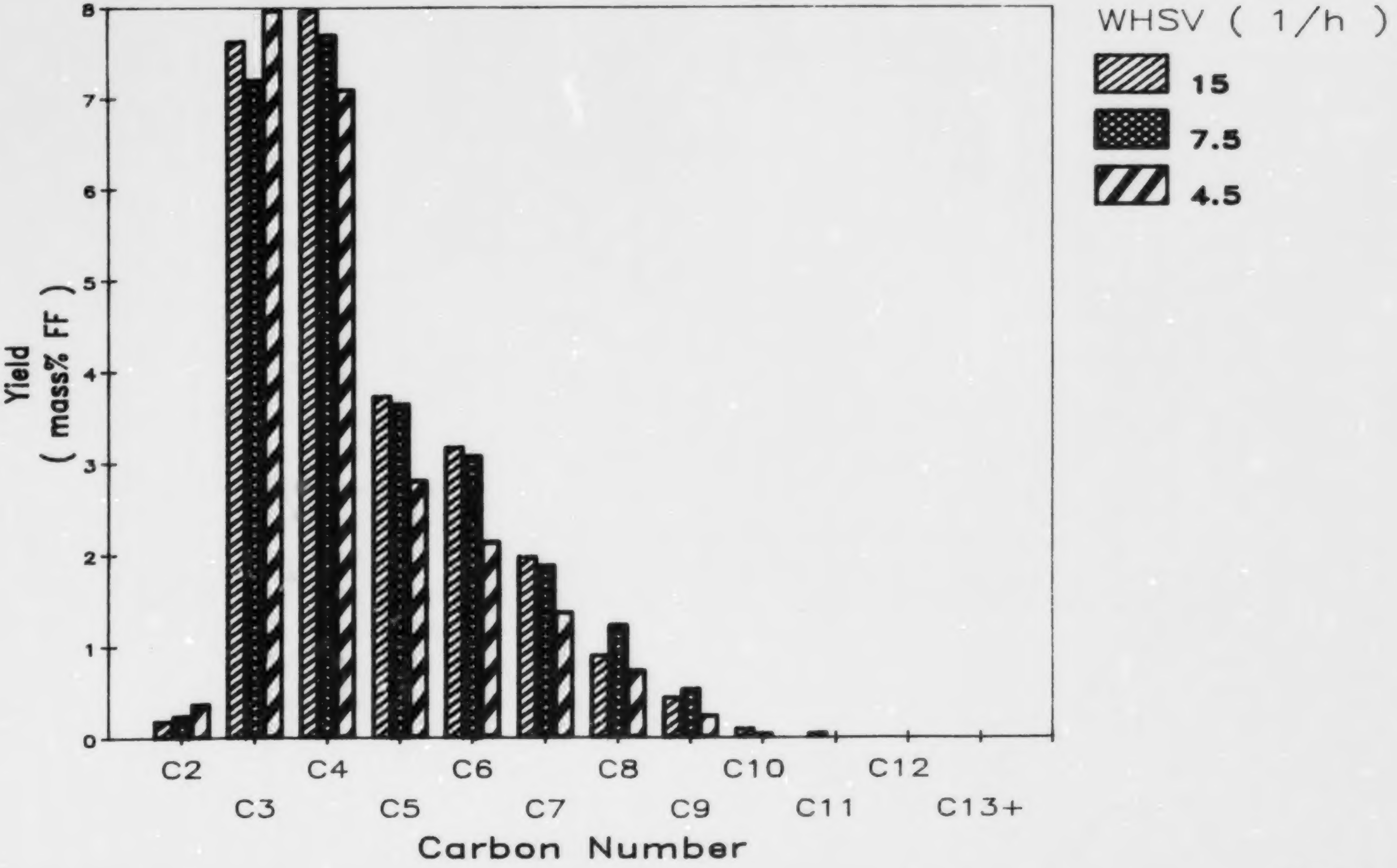
2,4,6,10-Tetramethylpentadecane



Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION

2,4,6,10-Tetramethylpentadecane

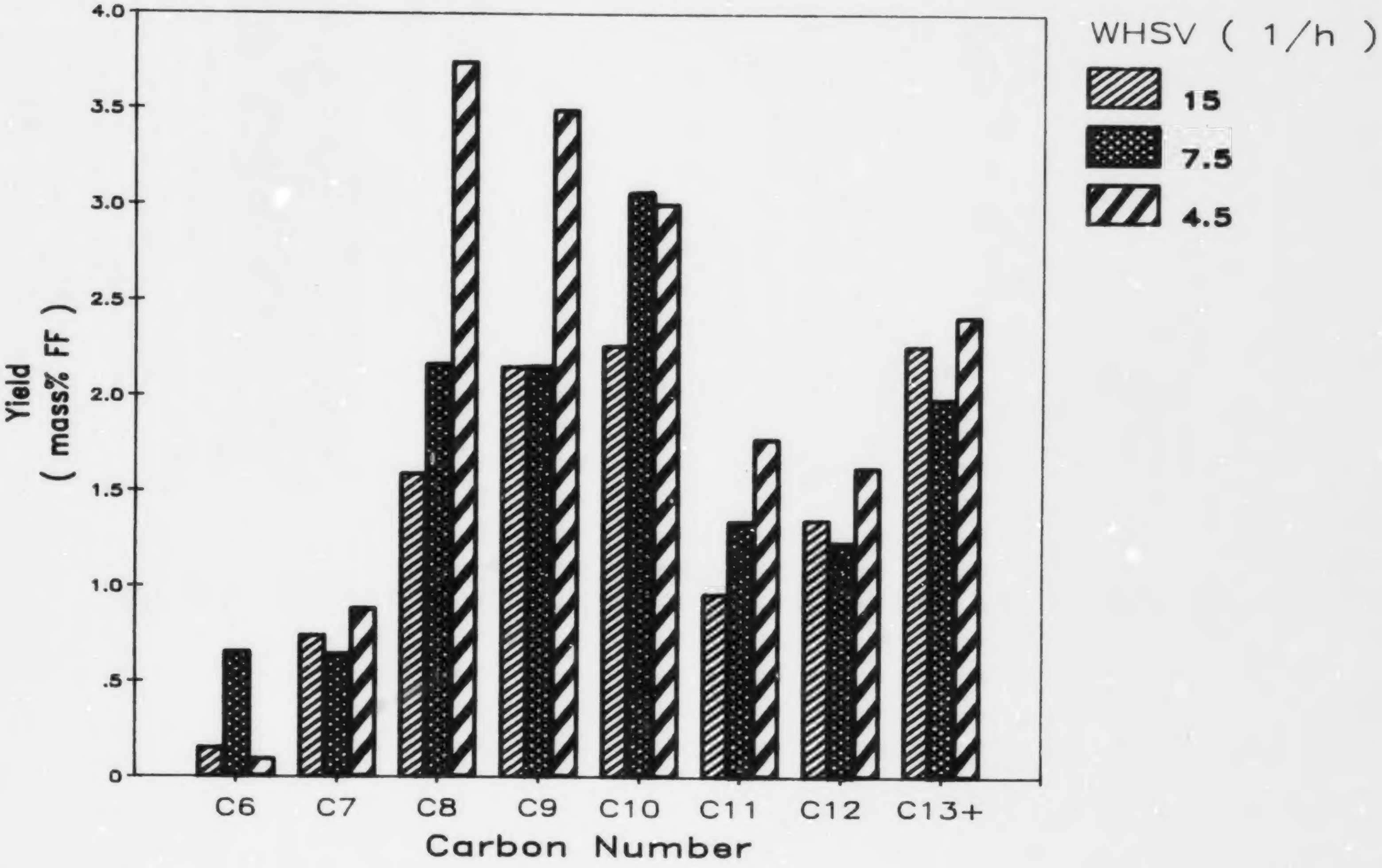


T2OTMPD

Task 2. Cradking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION

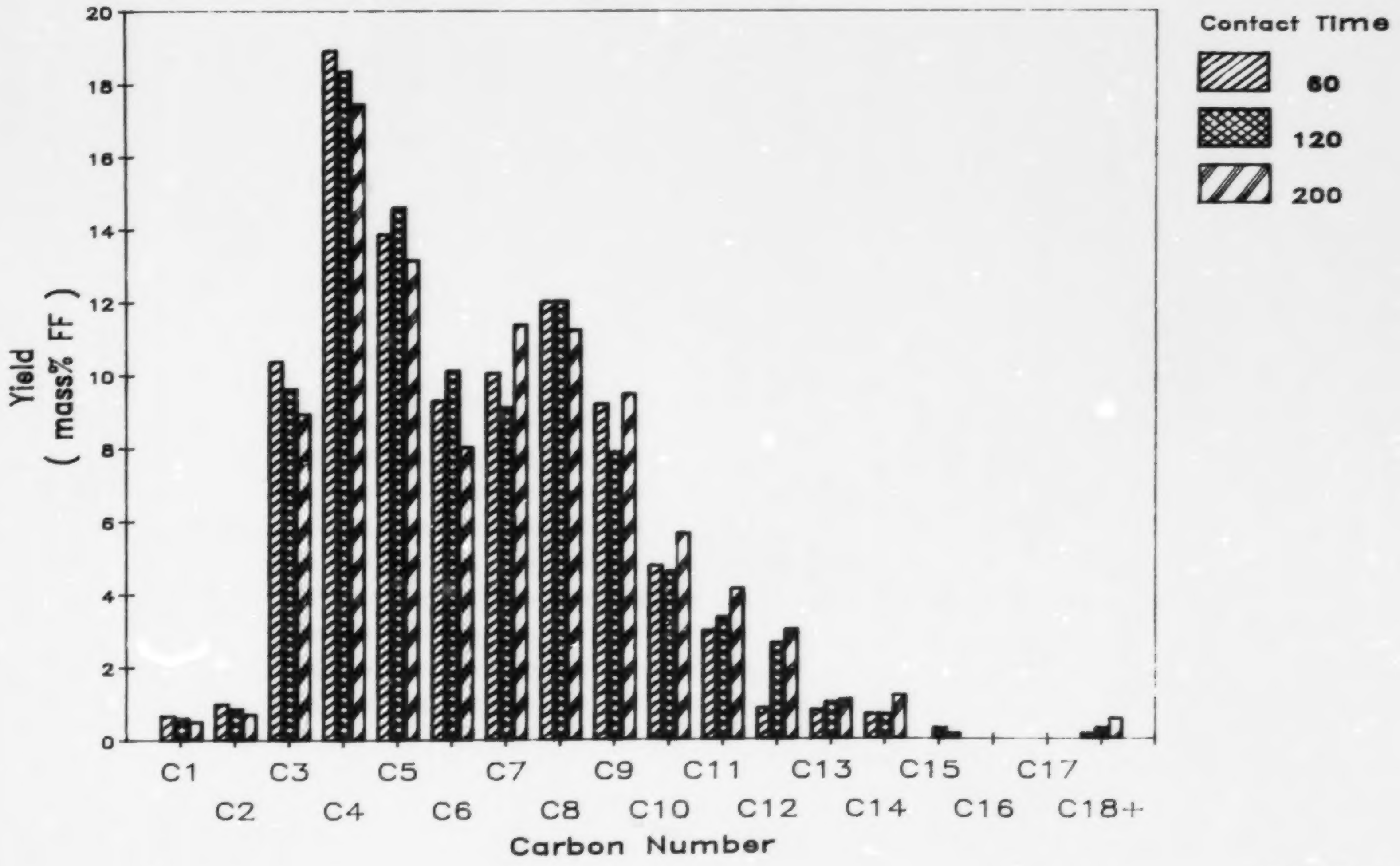
2,4,6,10-Tetramethylpentadecane



T2ATMPD

Task 2. Cracking Yields for other Hydrocarbons

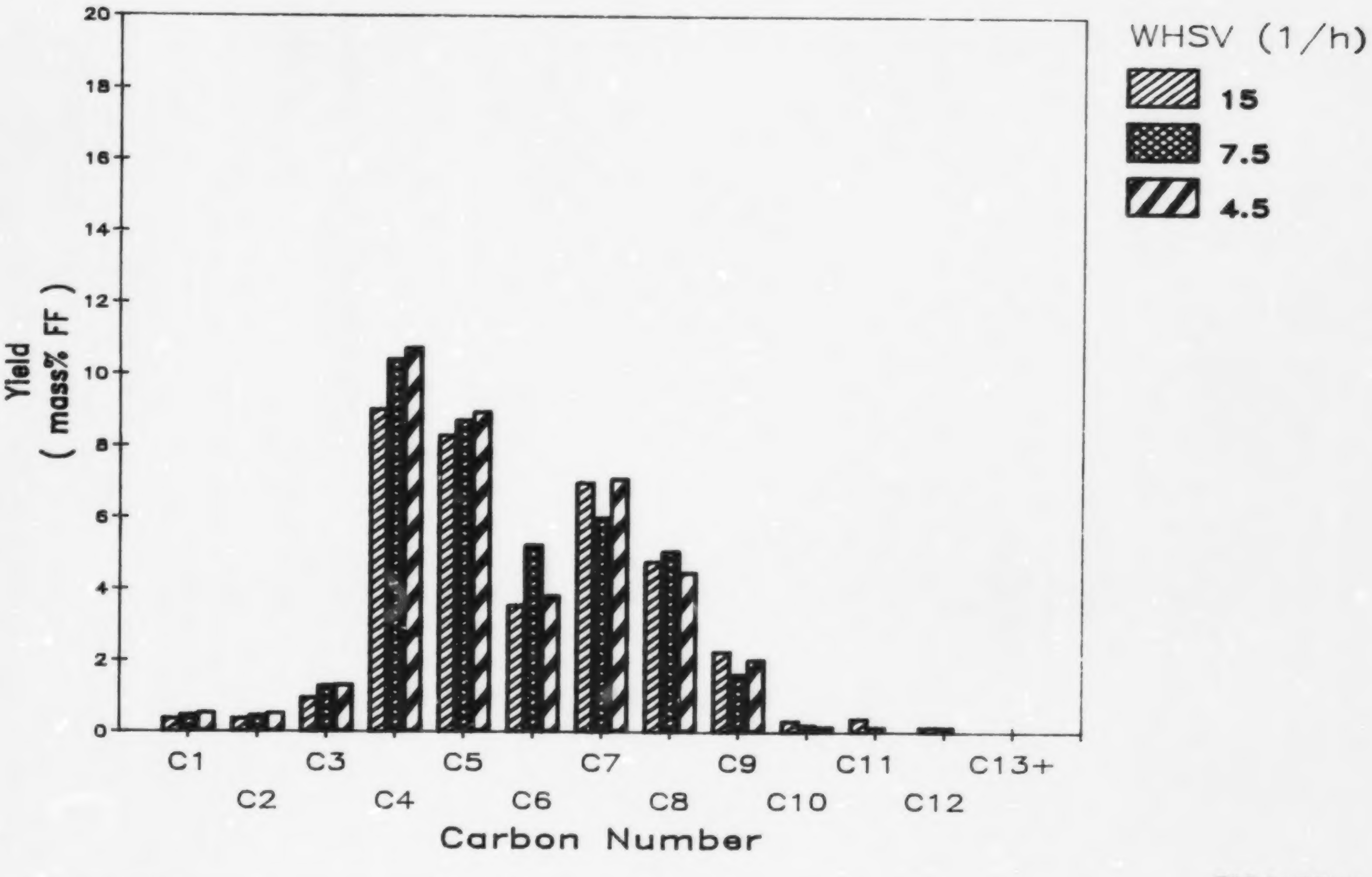
REACTOR EFFLUENT CARBON DISTRIBUTION
1 - Octadecene



T2C18CD

Task 2. Cracking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION
1-Octadecene

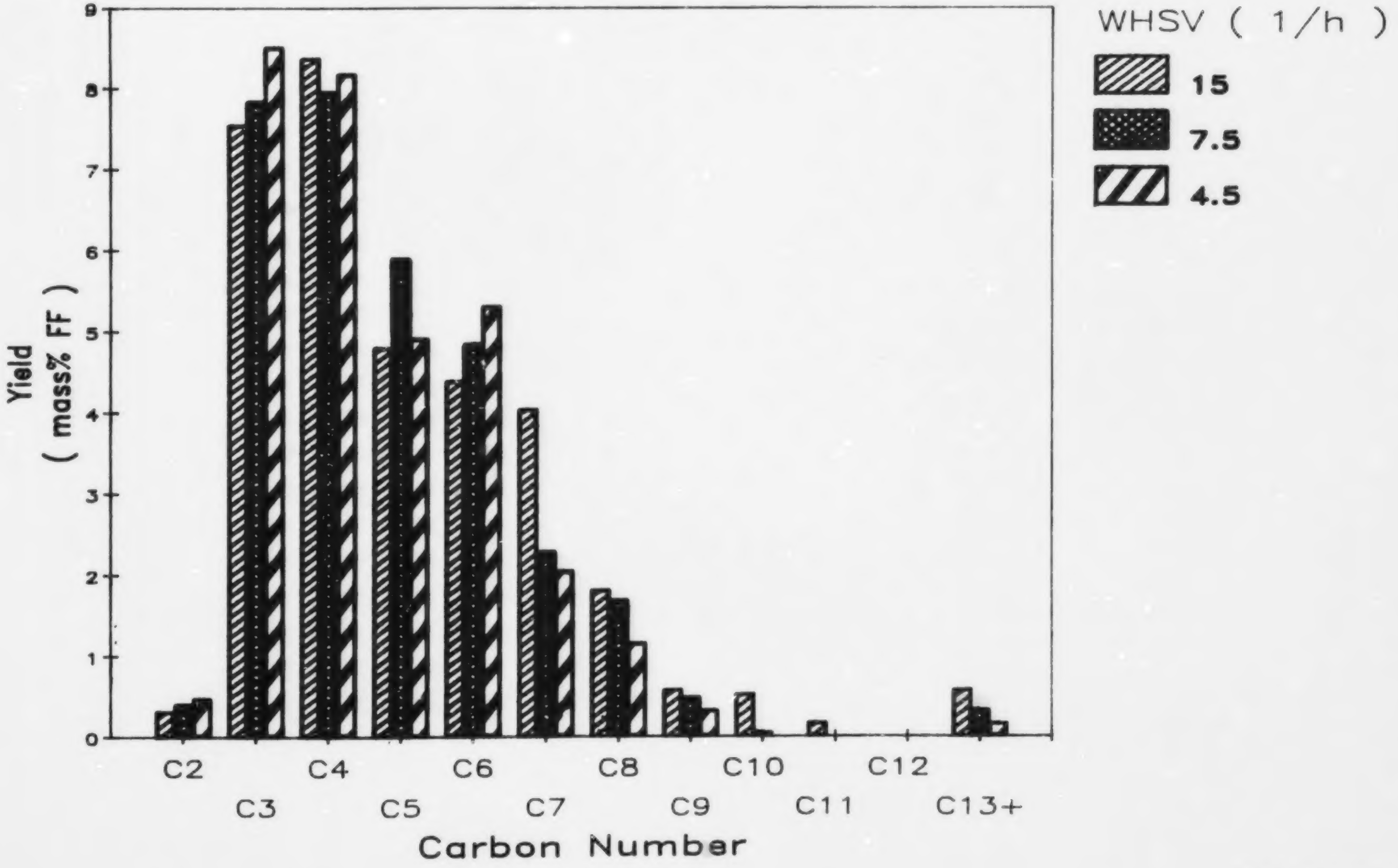


T2PC18ENE

Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION

1-Octadecene

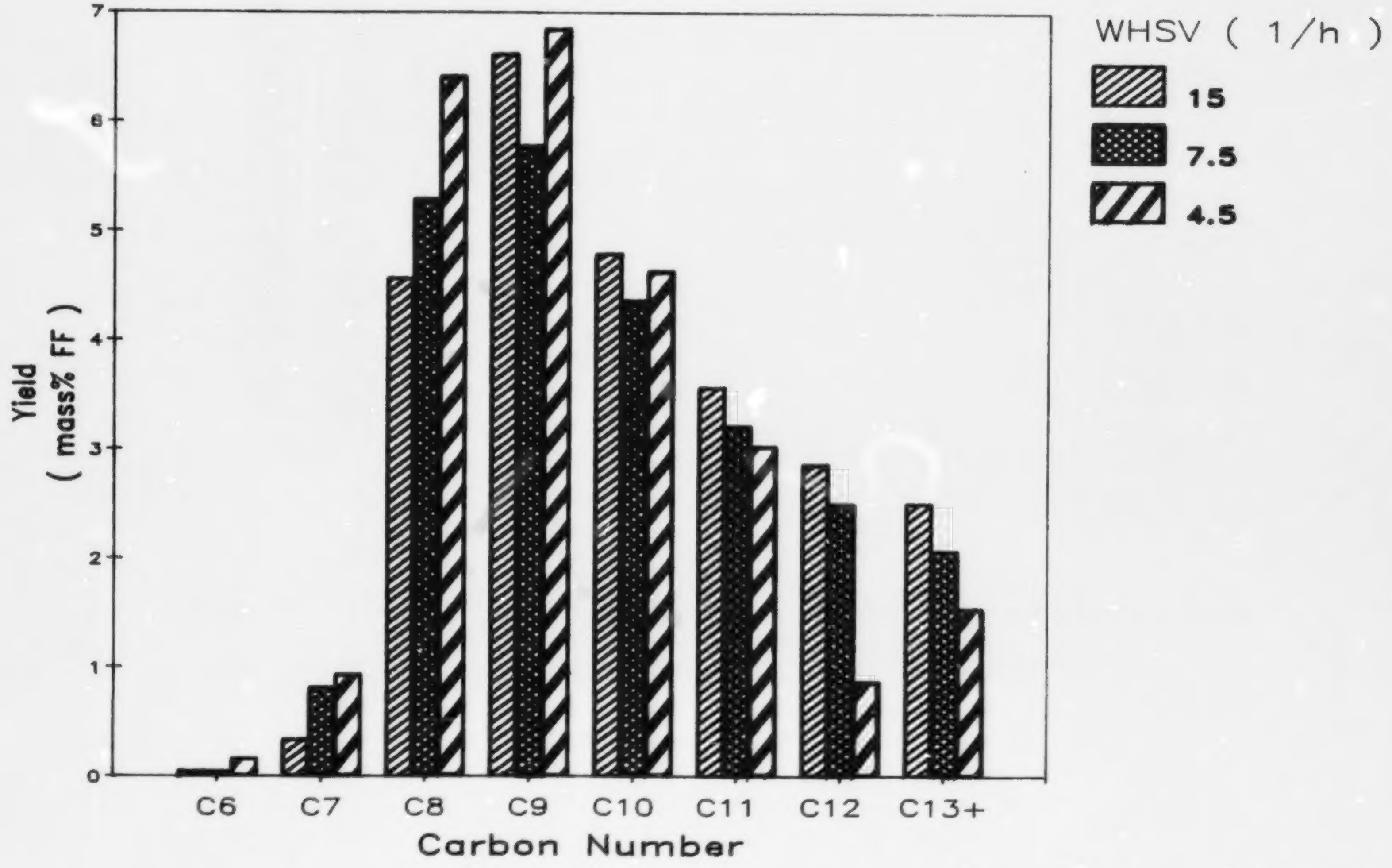


T2OC18ENE

Task 2. Cracking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION

1-Octadecene

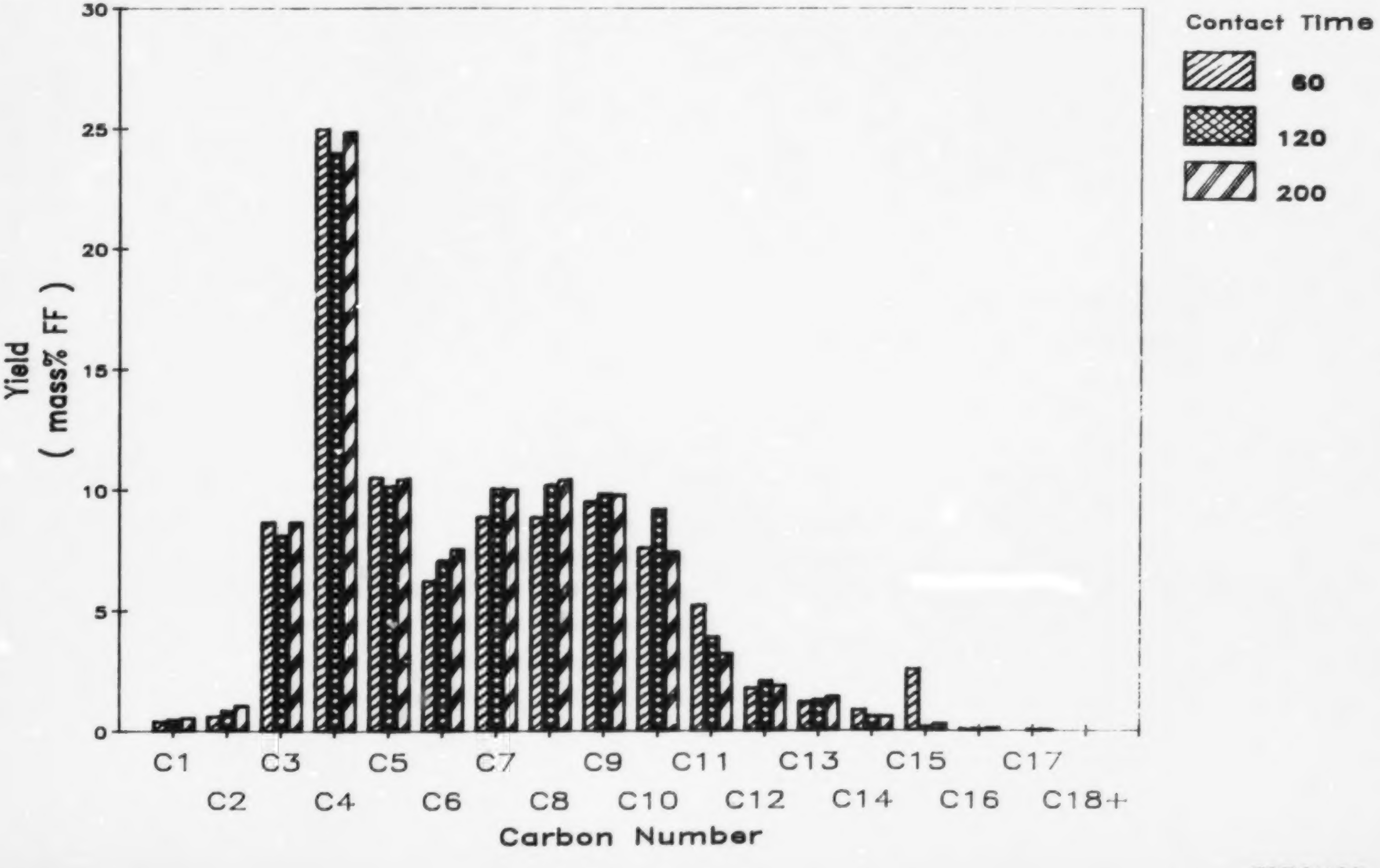


T2AC18ENE

Task 2. Cracking Yields for other Hydrocarbons

REACTOR EFFLUENT CARBON DISTRIBUTION

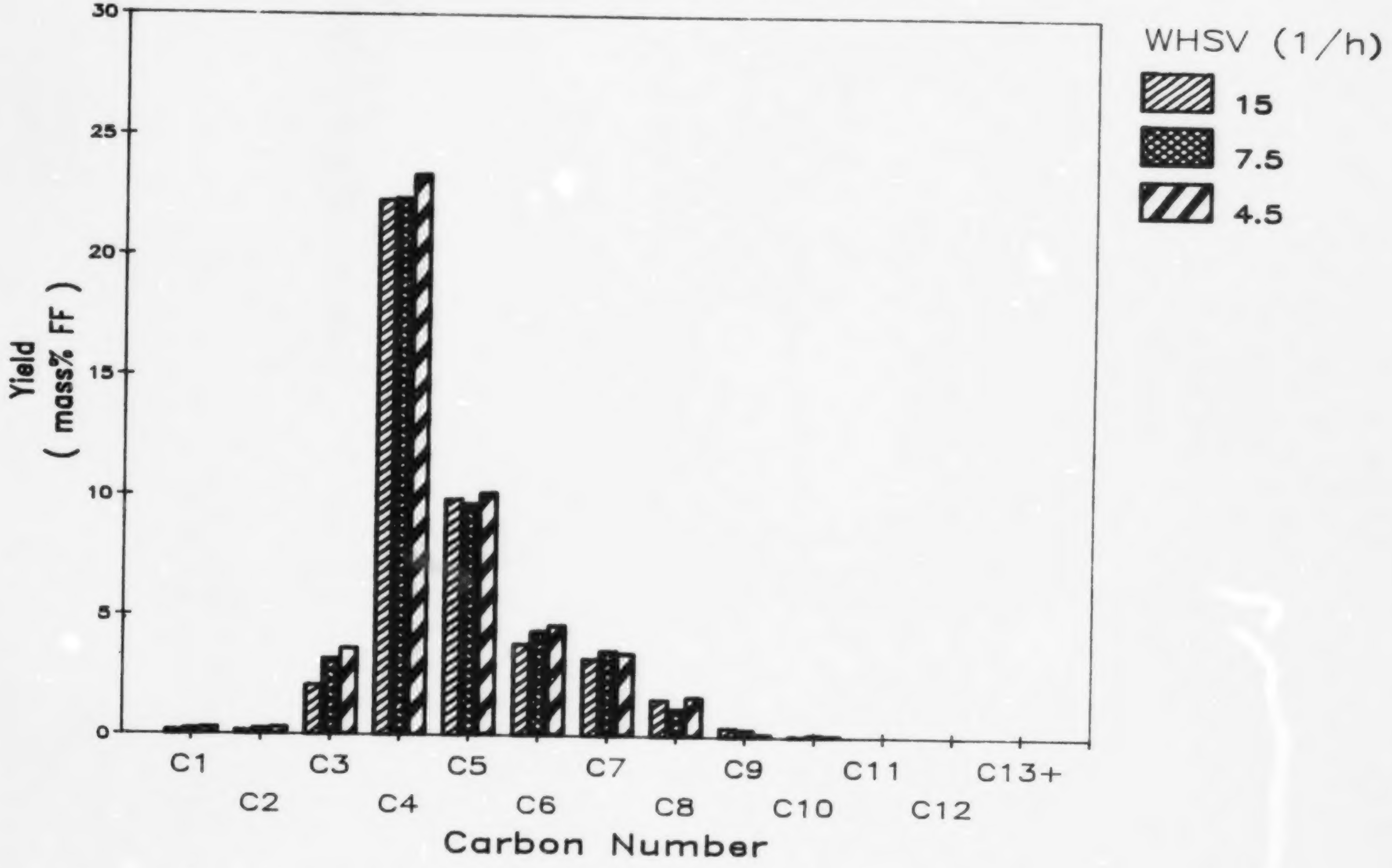
1,3,5 - Triisopropylcyclohexane



T2PCHCD

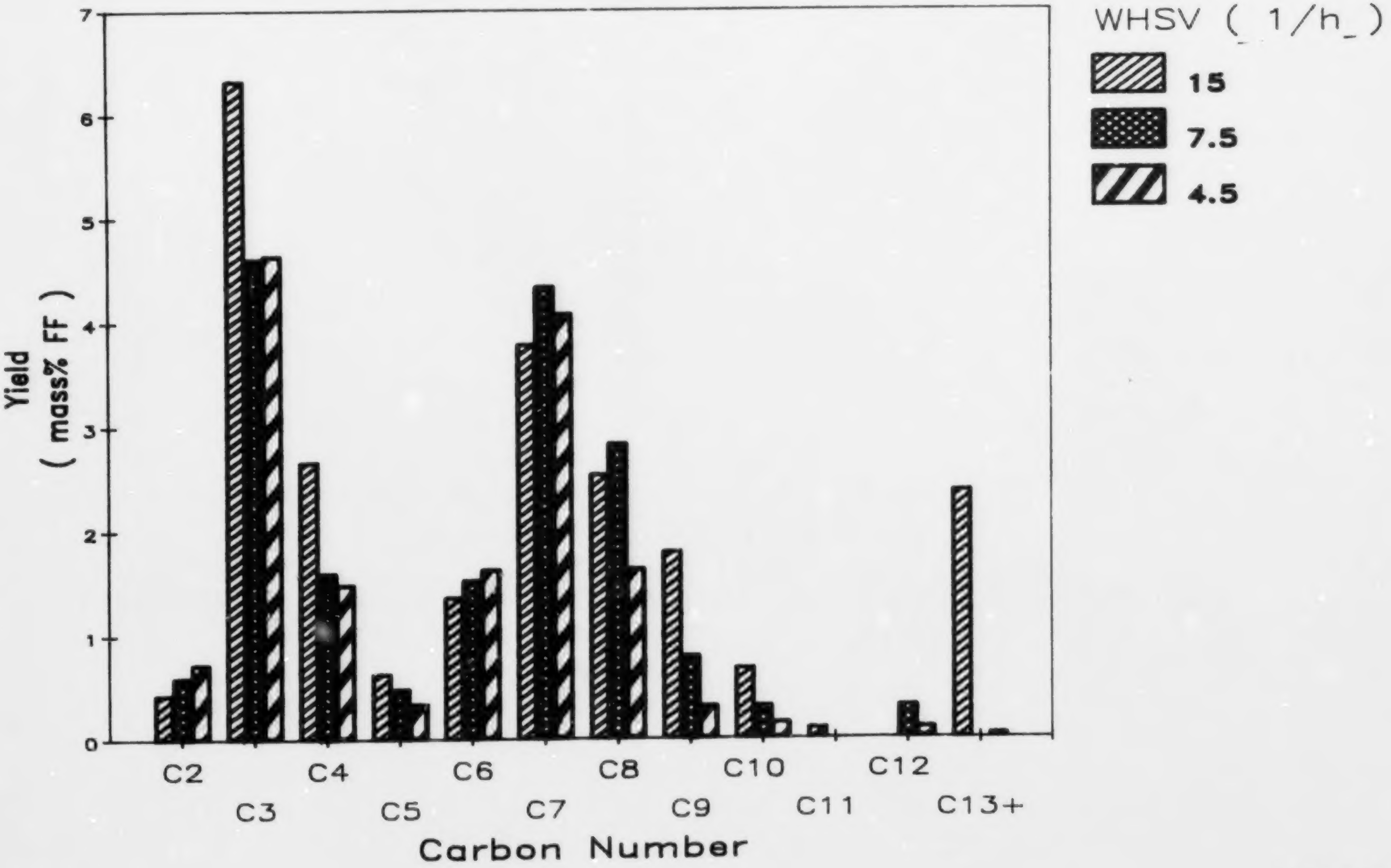
Task 2. Cracking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION
1,3,5-Tri-i-Propylcyclohexane



Task 2. Cracking Yields for other Hydrocarbons

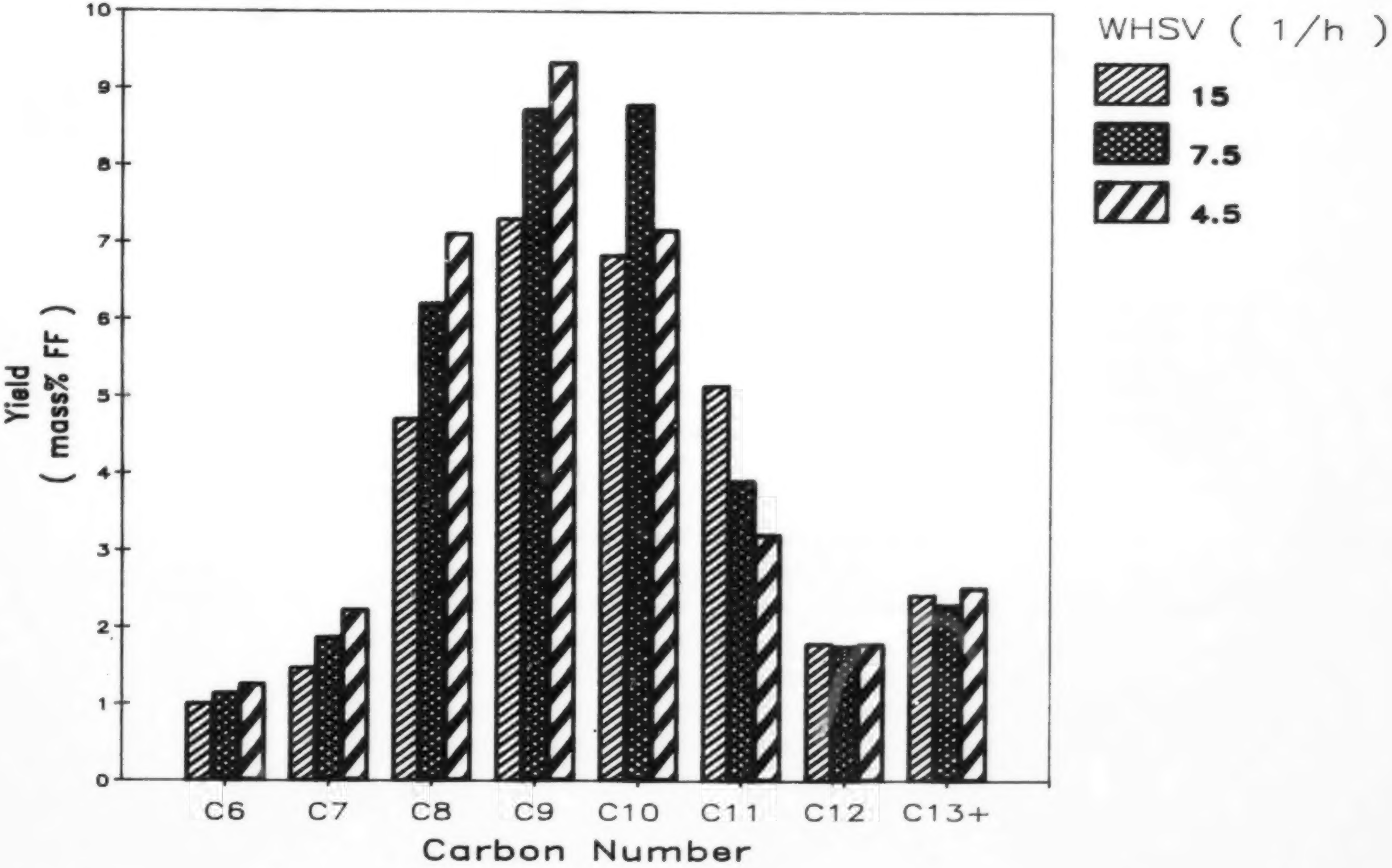
OLEFIN DISTRIBUTION
1,3,5-Tri-i-Propylcyclohexane



T2OTIPCH

Task 2. Cracking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION
1,3,5-Tri-I-Propylcyclohexane

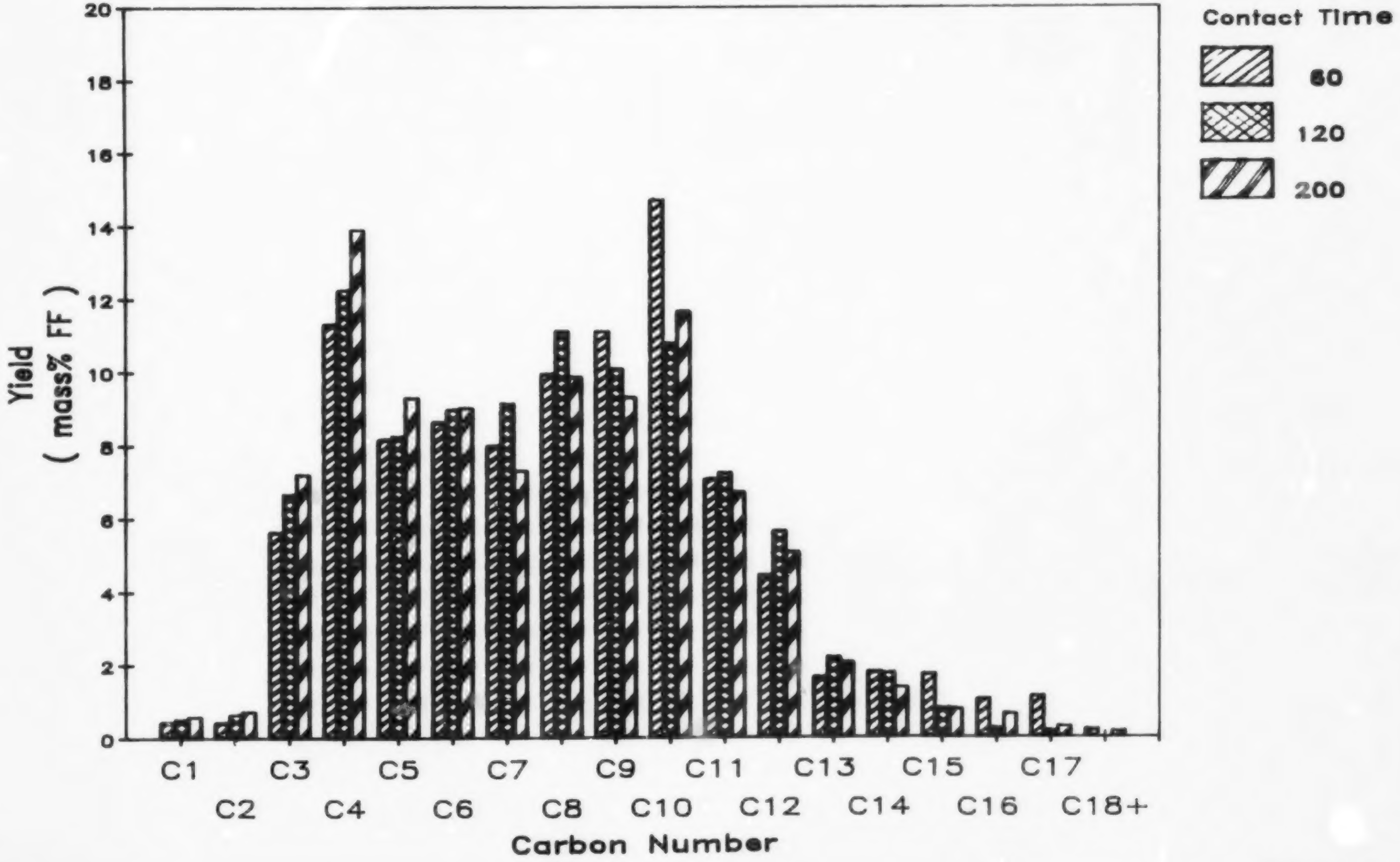


T2ATIPCH

Task 2. Cracking Yields for other Hydrocarbons

REACTOR EFFLUENT CARBON DISTRIBUTION

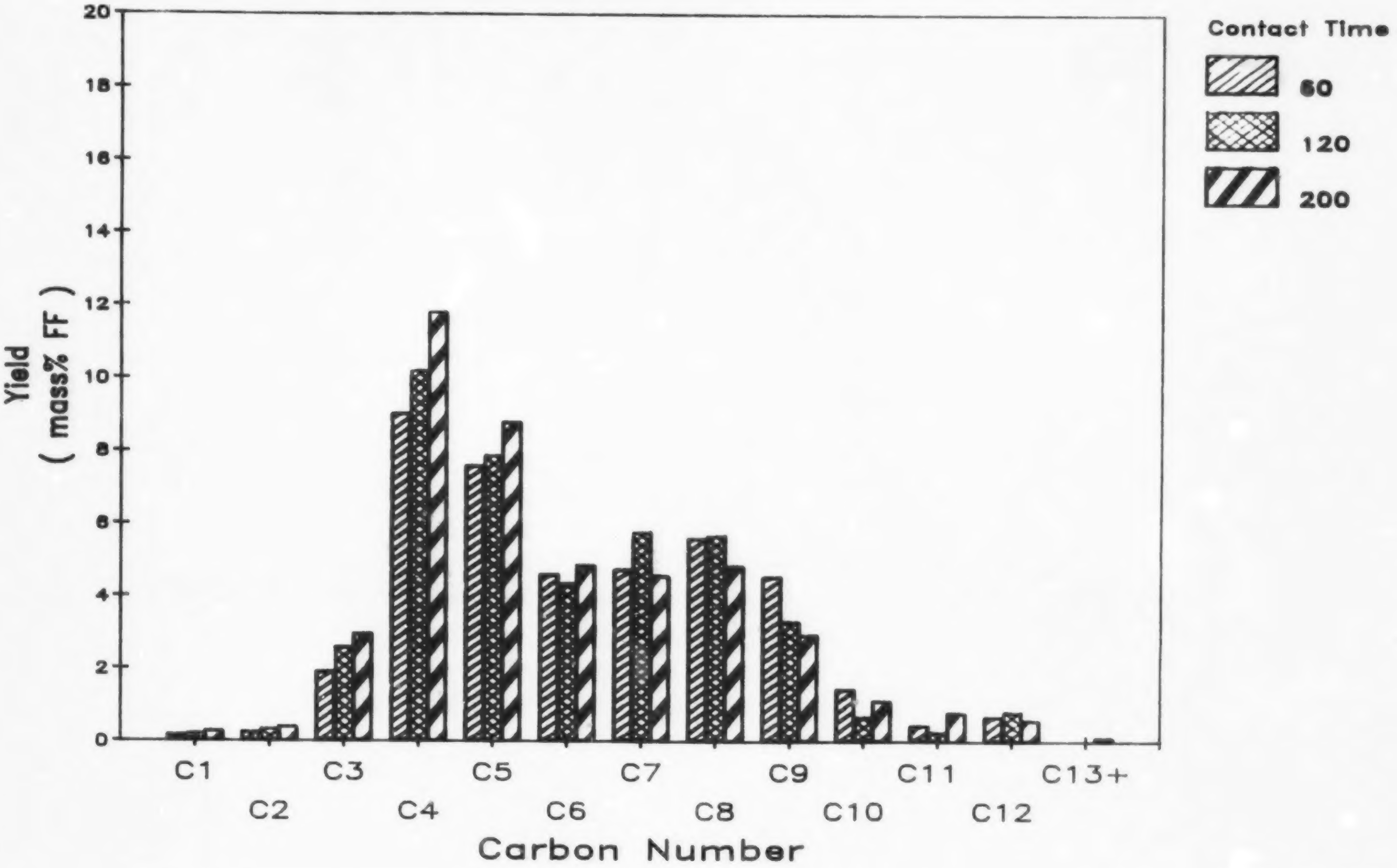
1 - Phenyldodecane



T21P12CD

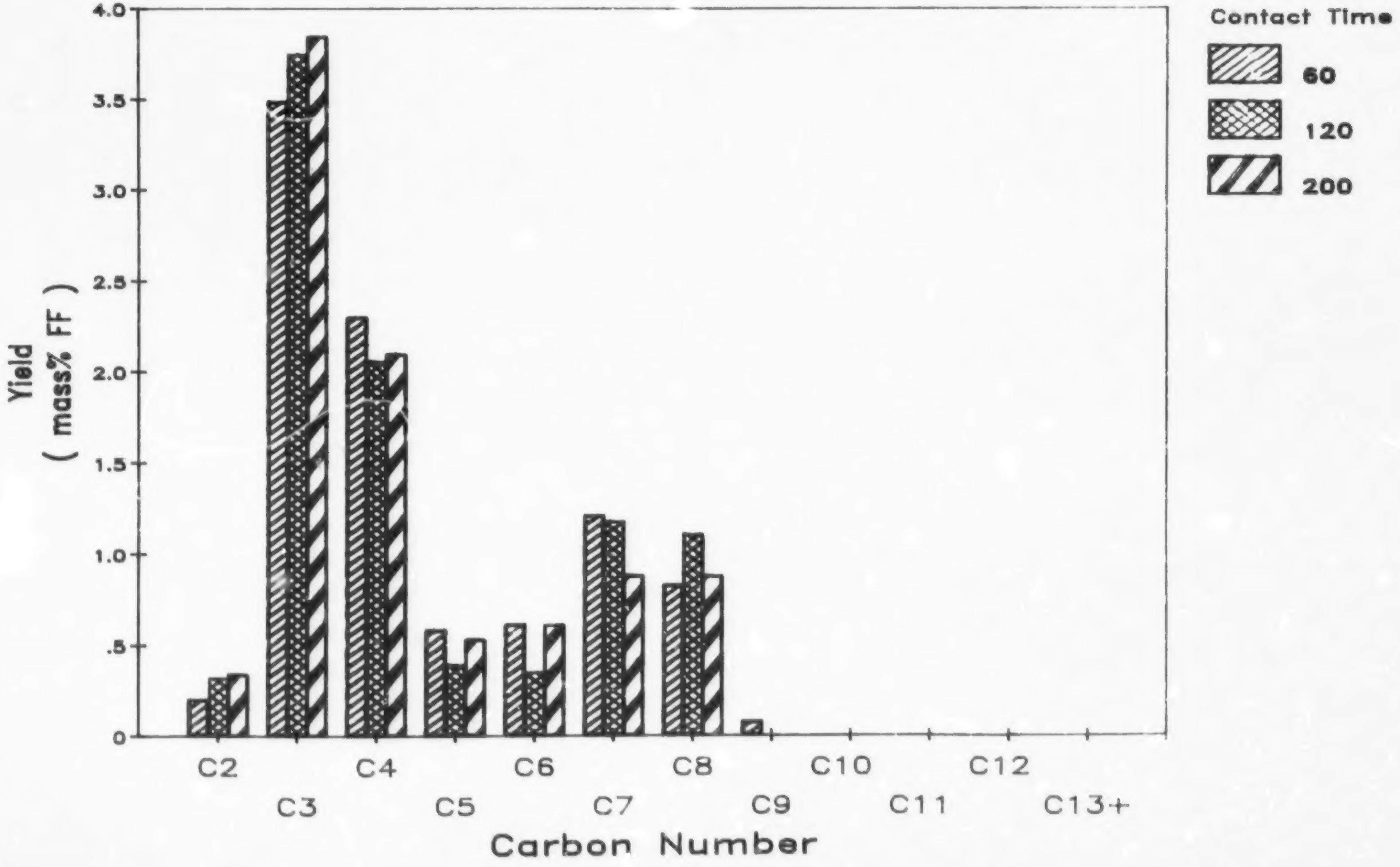
Task 2. Cracking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION
1-Phenyldodecane



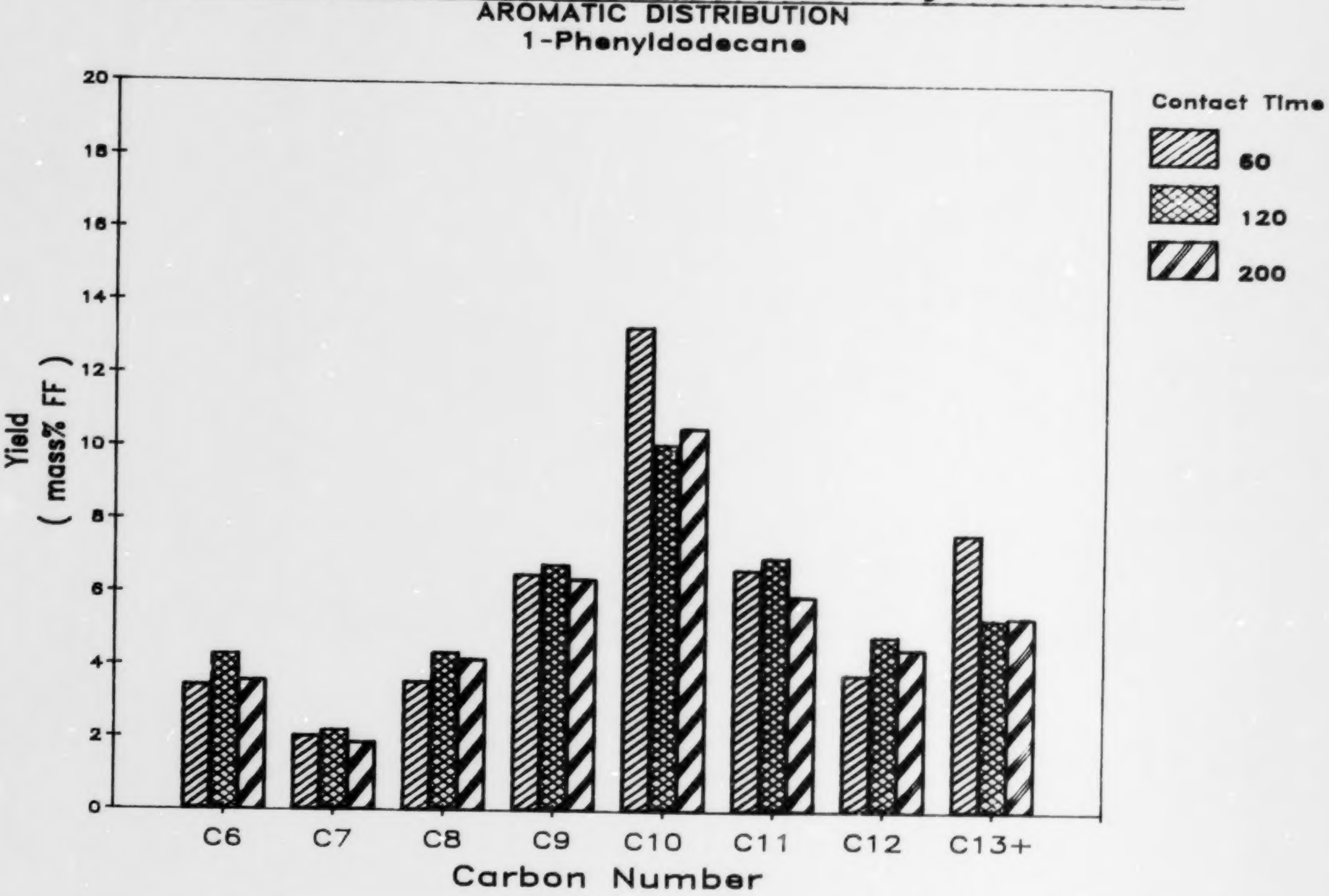
Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION
1-Phenyldodecane



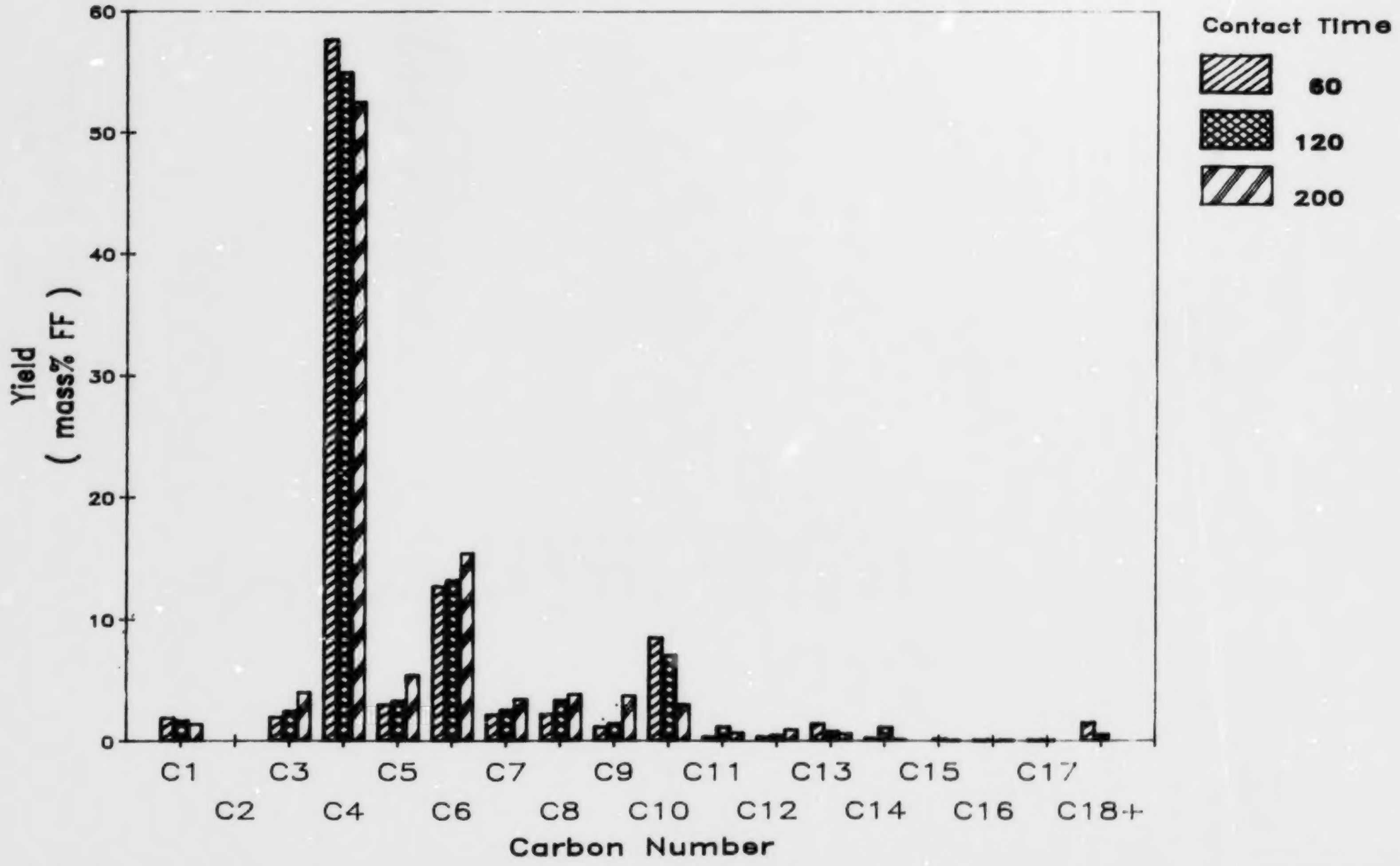
T201PC12

Task 2. Cracking Yields for other Hydrocarbons



Task 2. Cracking Yields for other Hydrocarbons

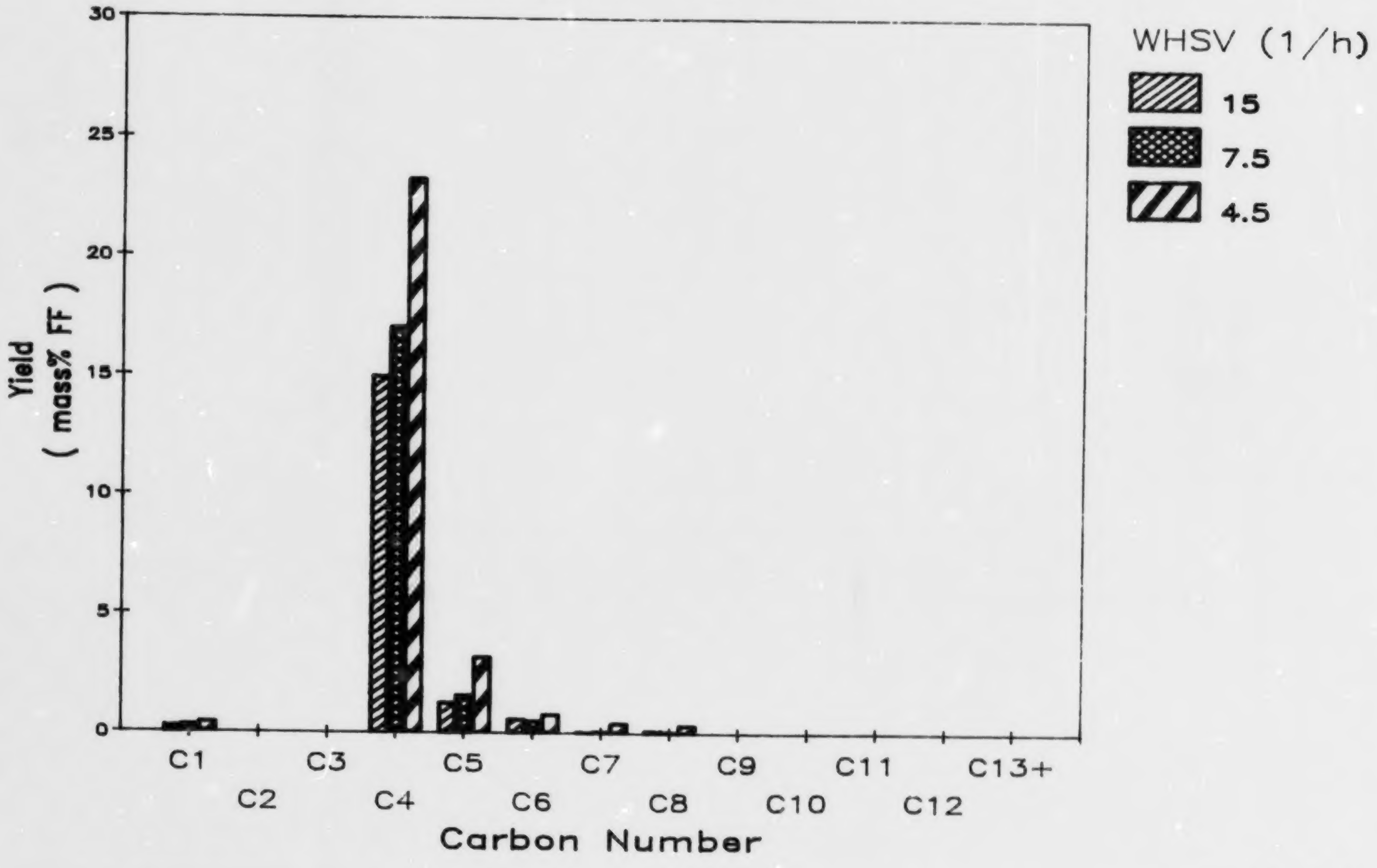
REACTOR EFFLUENT CARBON DISTRIBUTION
1,3,5 - Tri-t-Butylbenzene



T2TTBBCD

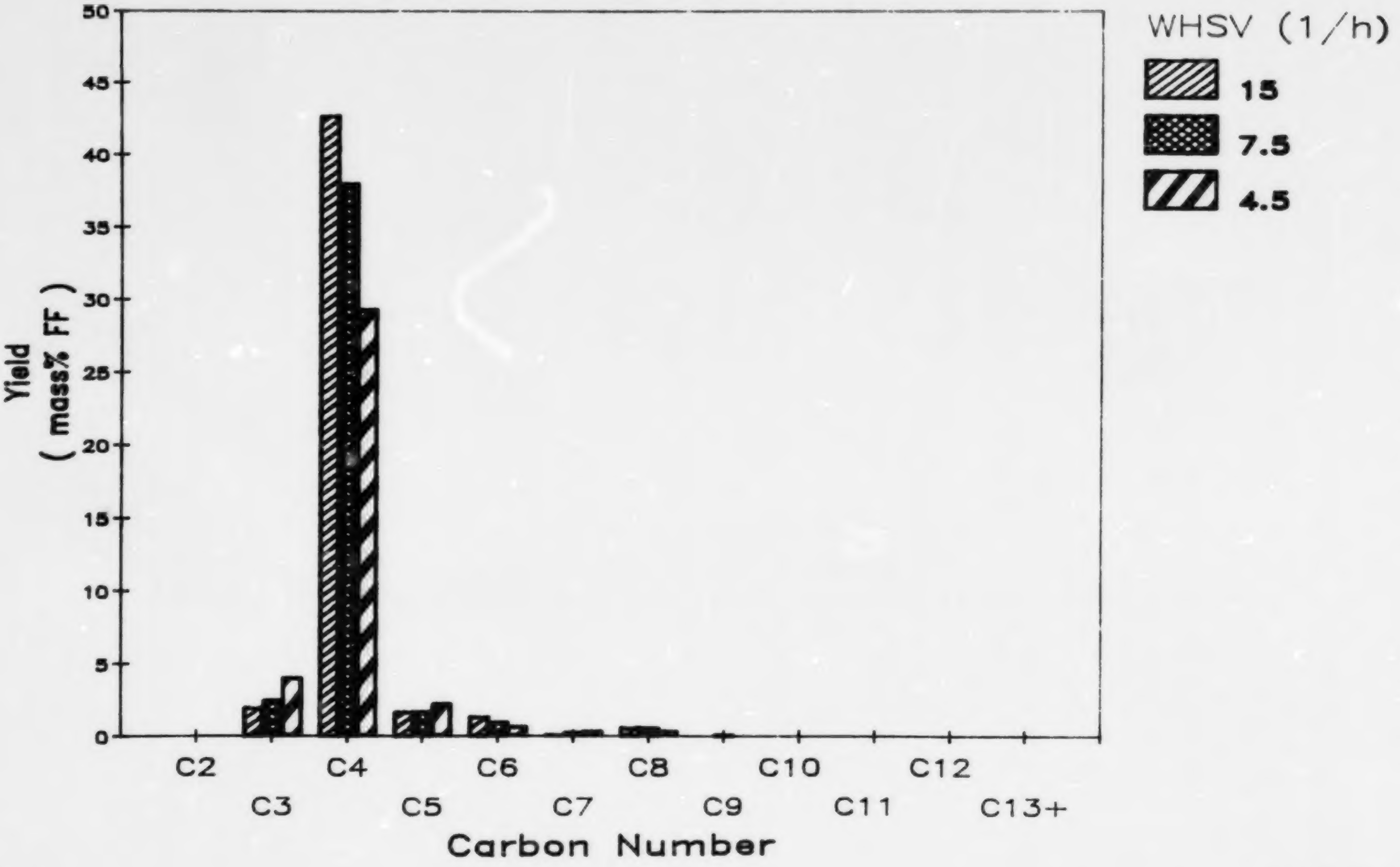
Task 2. Cracking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION
1,3,5-Tri-t-Butylbenzene



Task 2. Cracking Yields for other Hydrocarbons

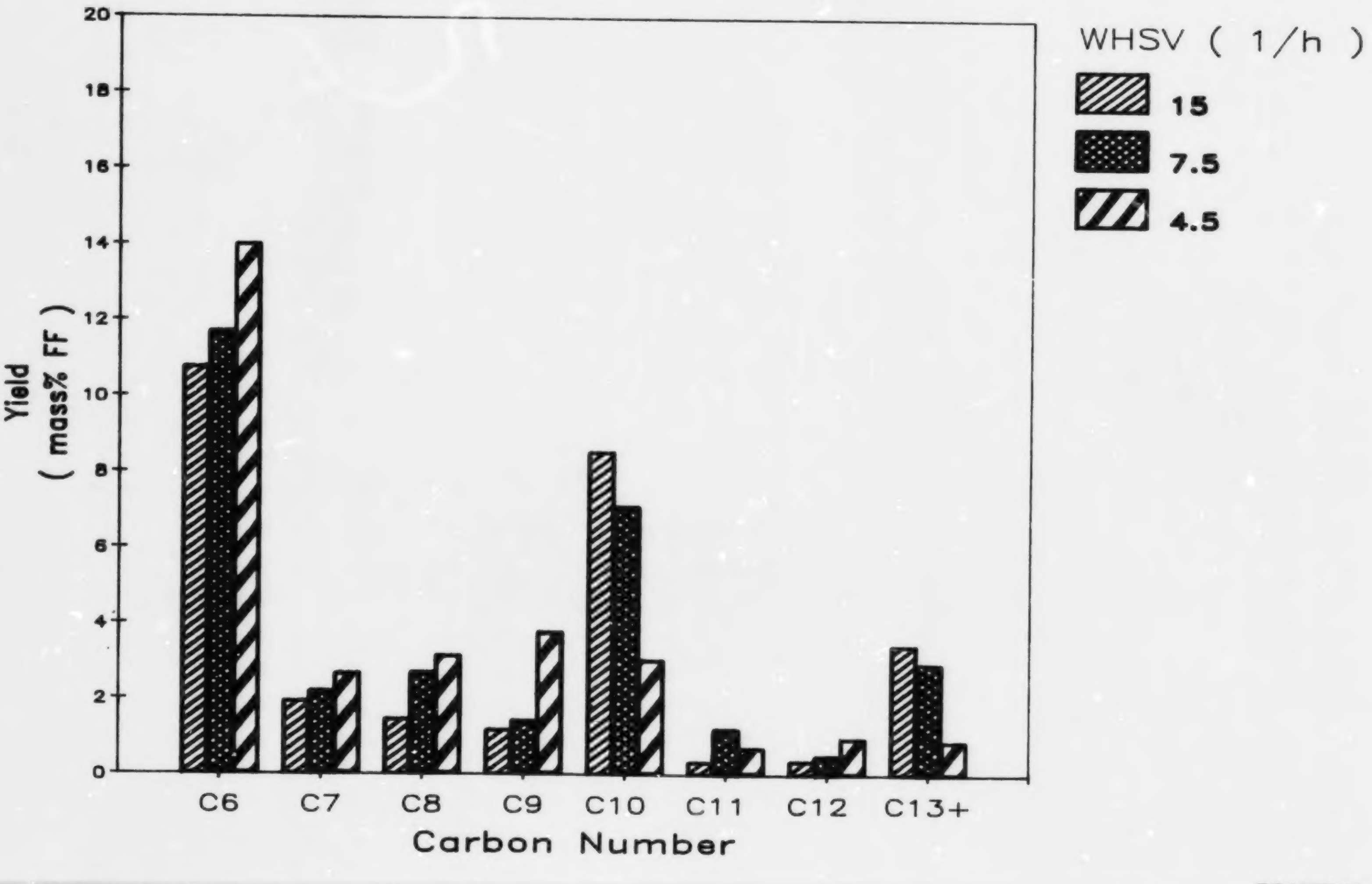
OLEFIN DISTRIBUTION
1,3,5-Tri-t-Butylbenzene



T20TTBB

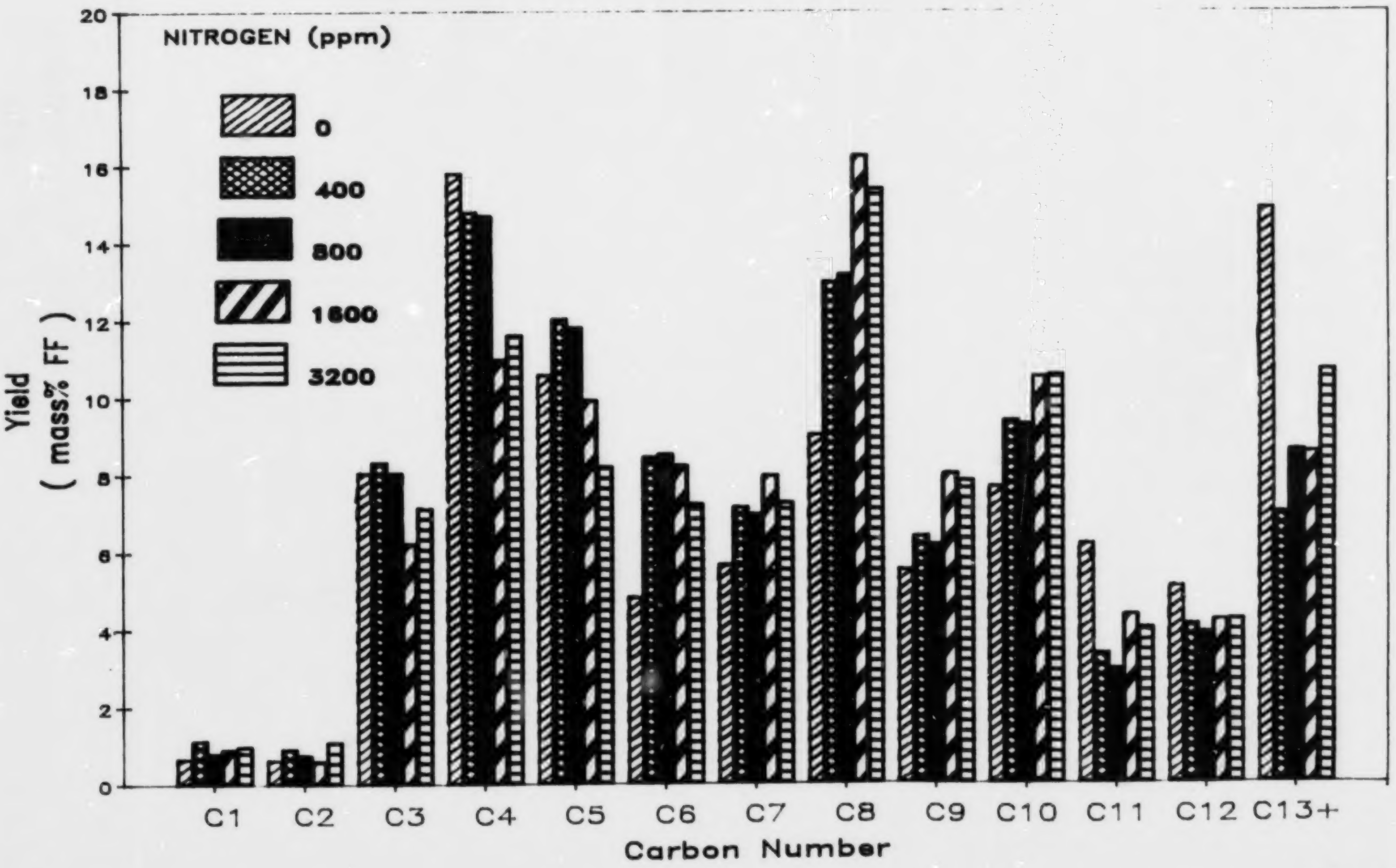
Task 2. Cracking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION
1,3,5-Tri-t-Butylbenzene



Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION
Blend A

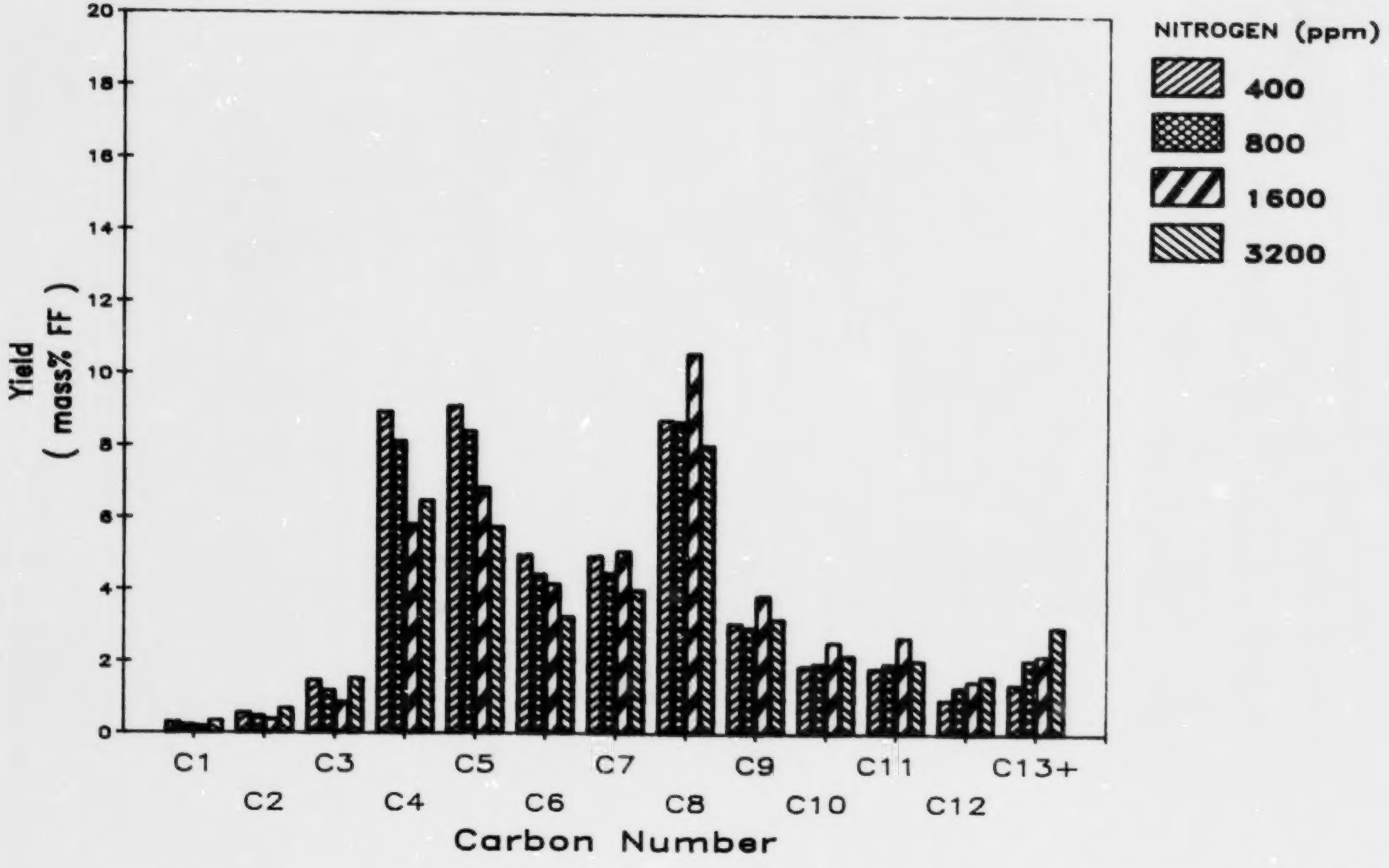


T3AACD

Task 3.A. Effects of Nitrogen Poisoning

PARAFFIN DISTRIBUTION

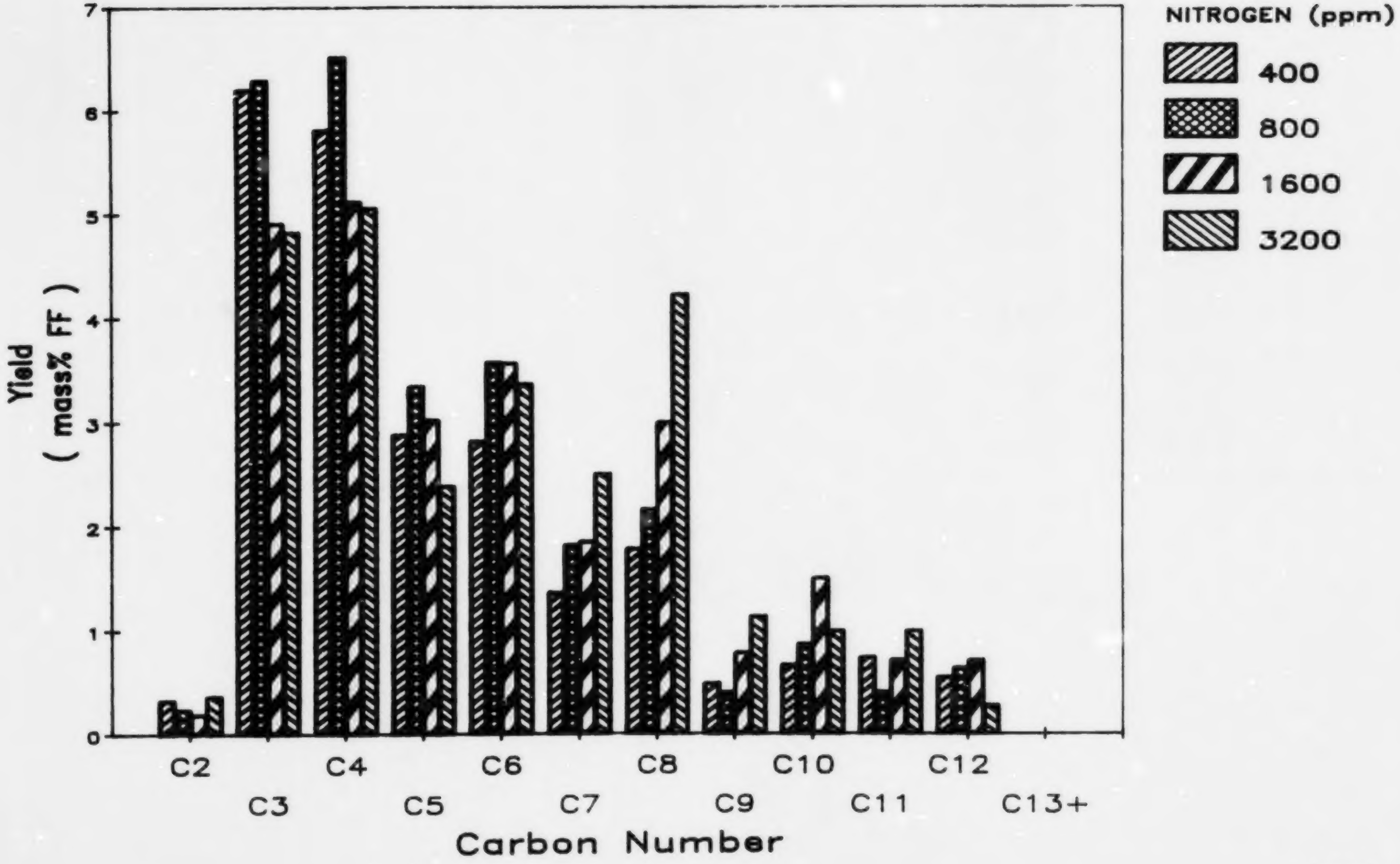
Blend A



T3APA

Task 3.A. Effects of Nitrogen Poisoning

OLEFIN DISTRIBUTION
Blend A

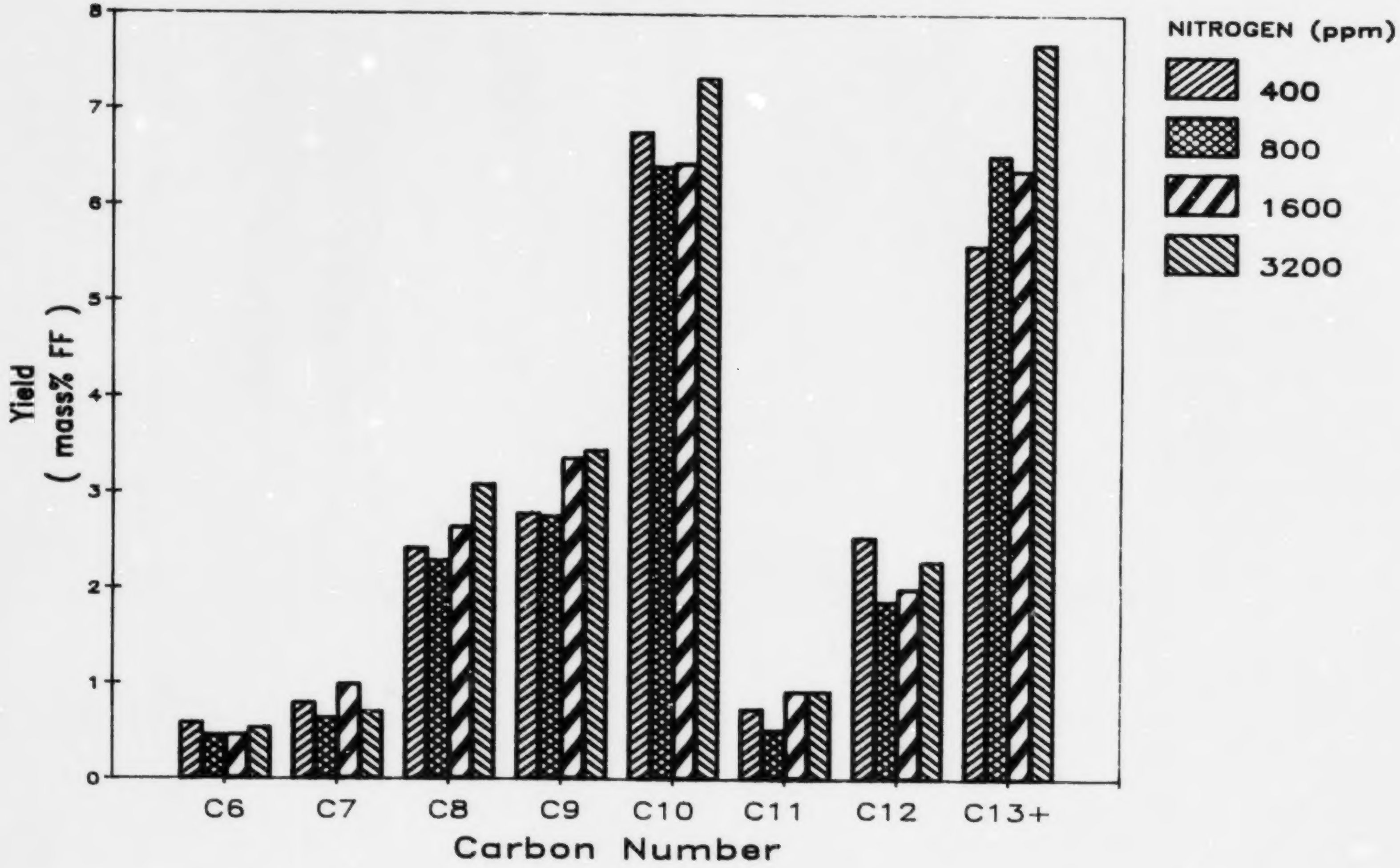


T3AOA

Task 3.A. Effects of Nitrogen Poisoning

AROMATIC DISTRIBUTION

Blend A

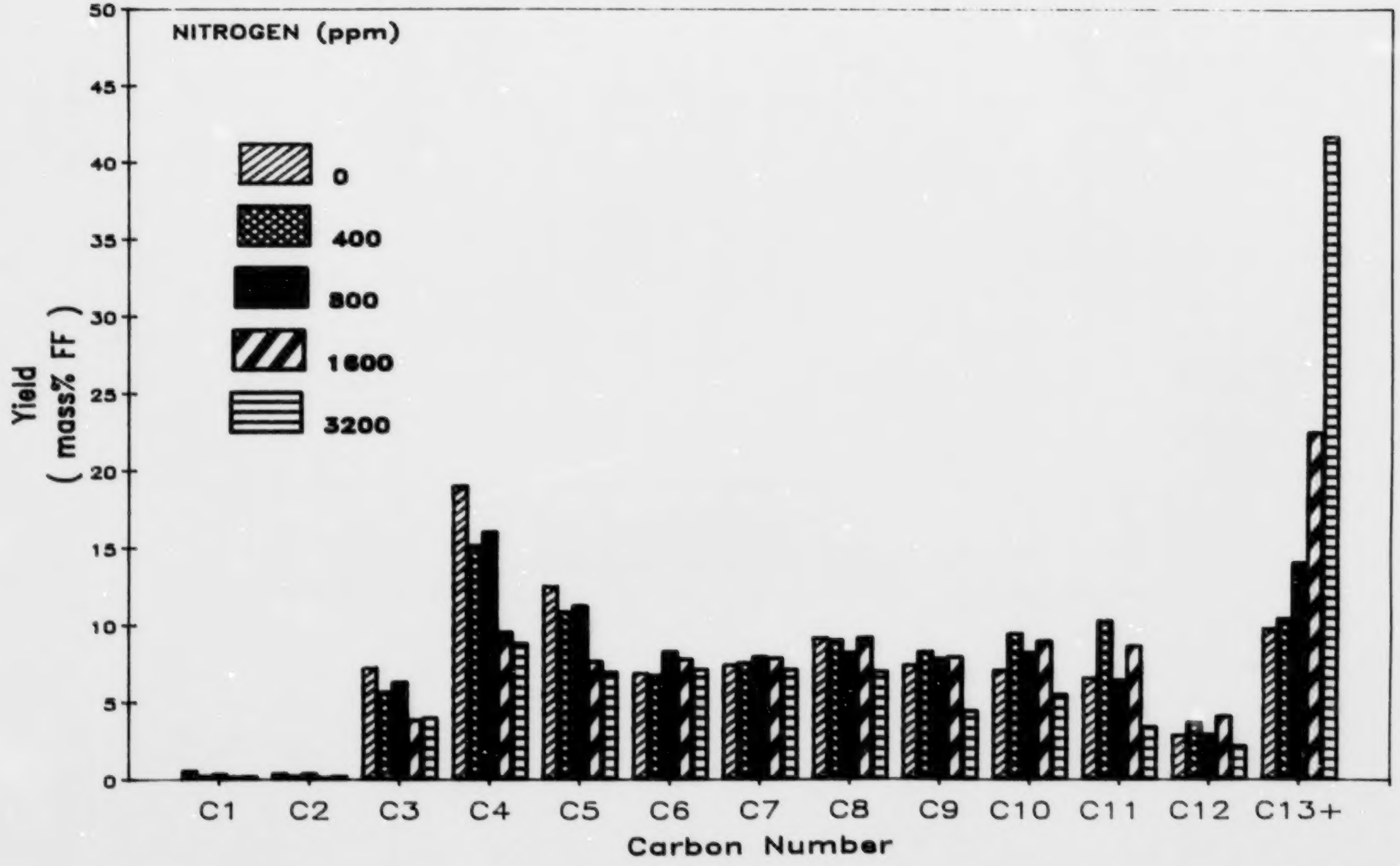


T3AAA

Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

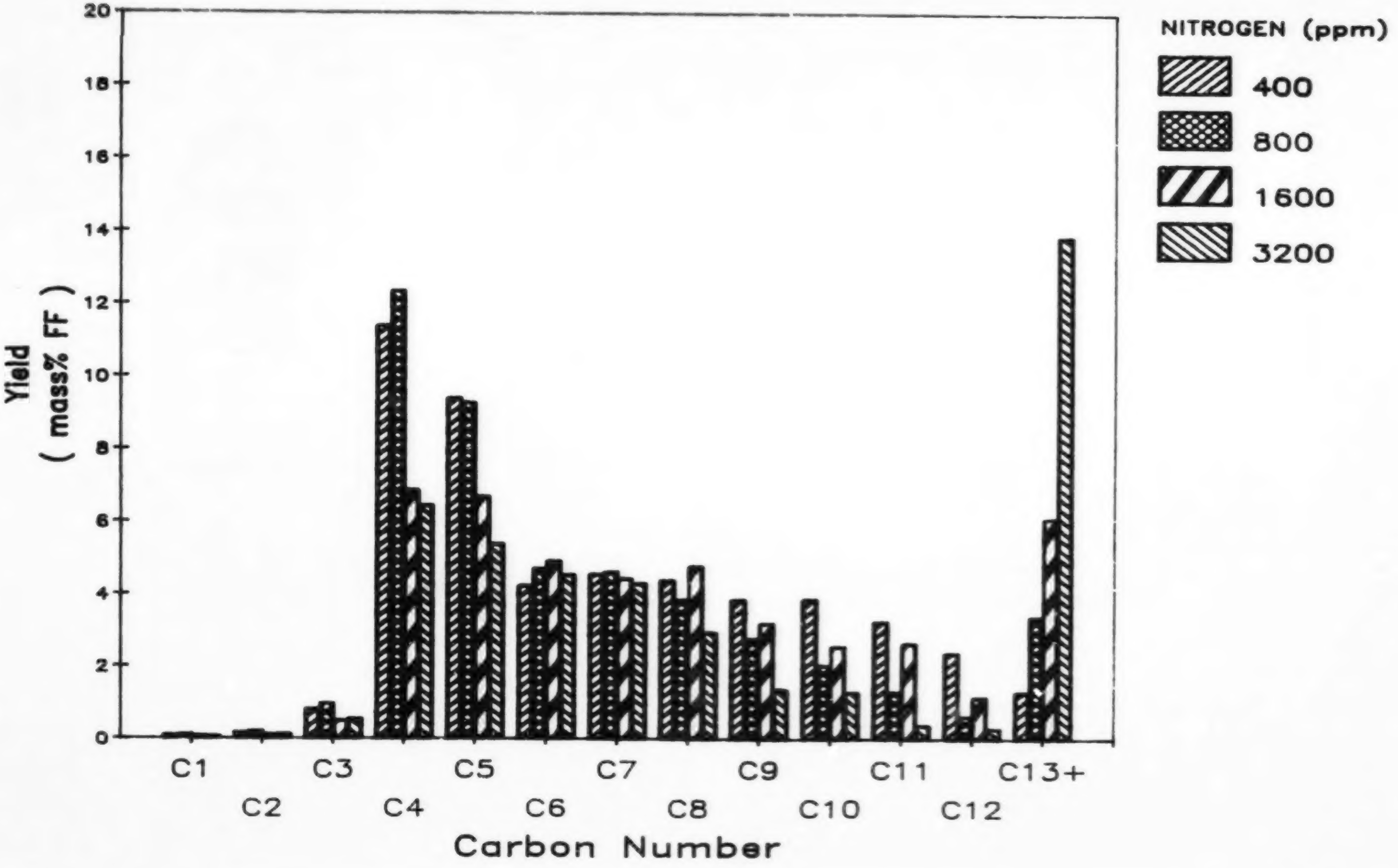
Blend B



T3ABCD

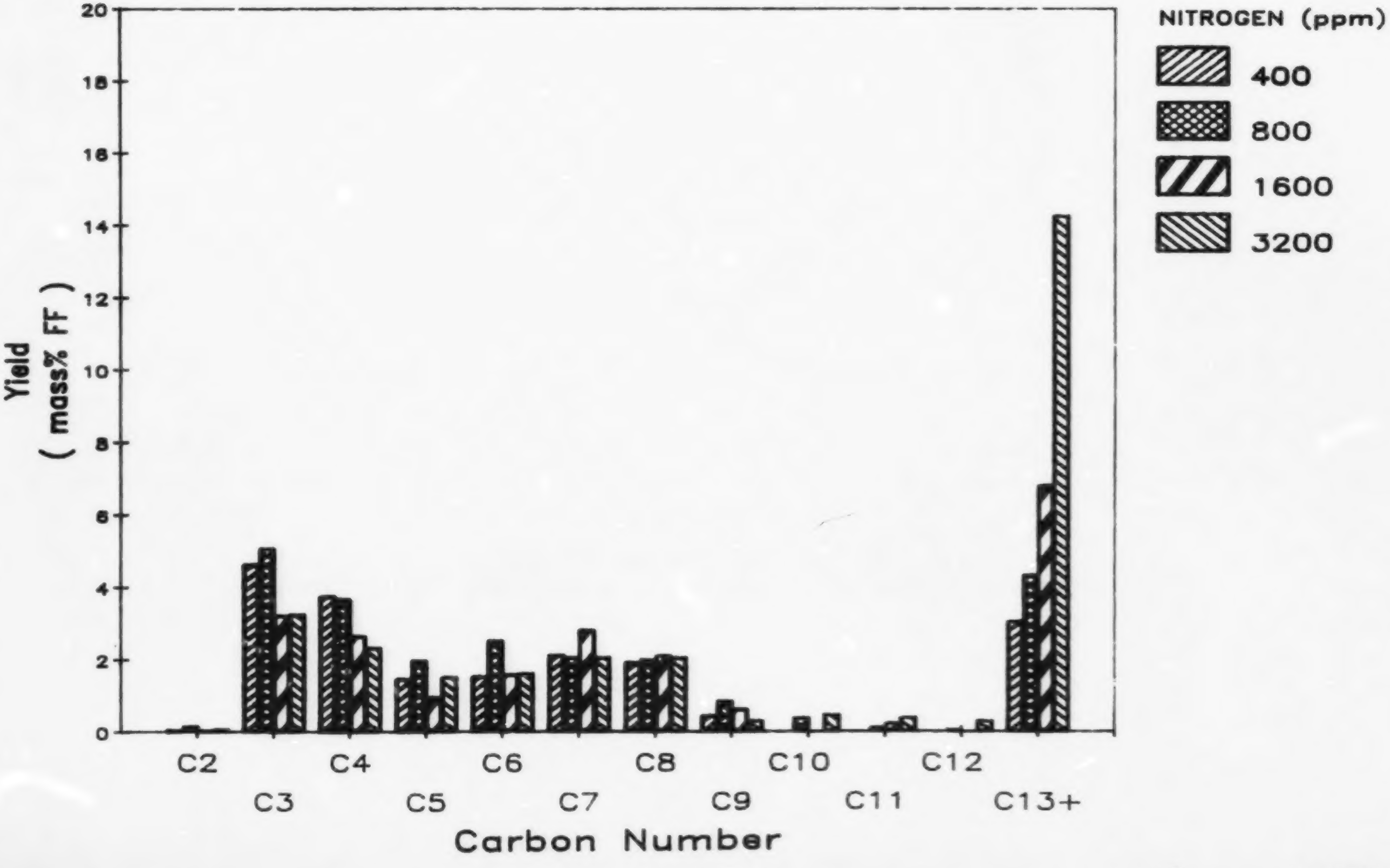
Task 3.A. Effects of Nitrogen Poisoning

PARAFFIN DISTRIBUTION
Blend B



Task 3.A. Effects of Nitrogen Poisoning

OLEFIN DISTRIBUTION
Blend B

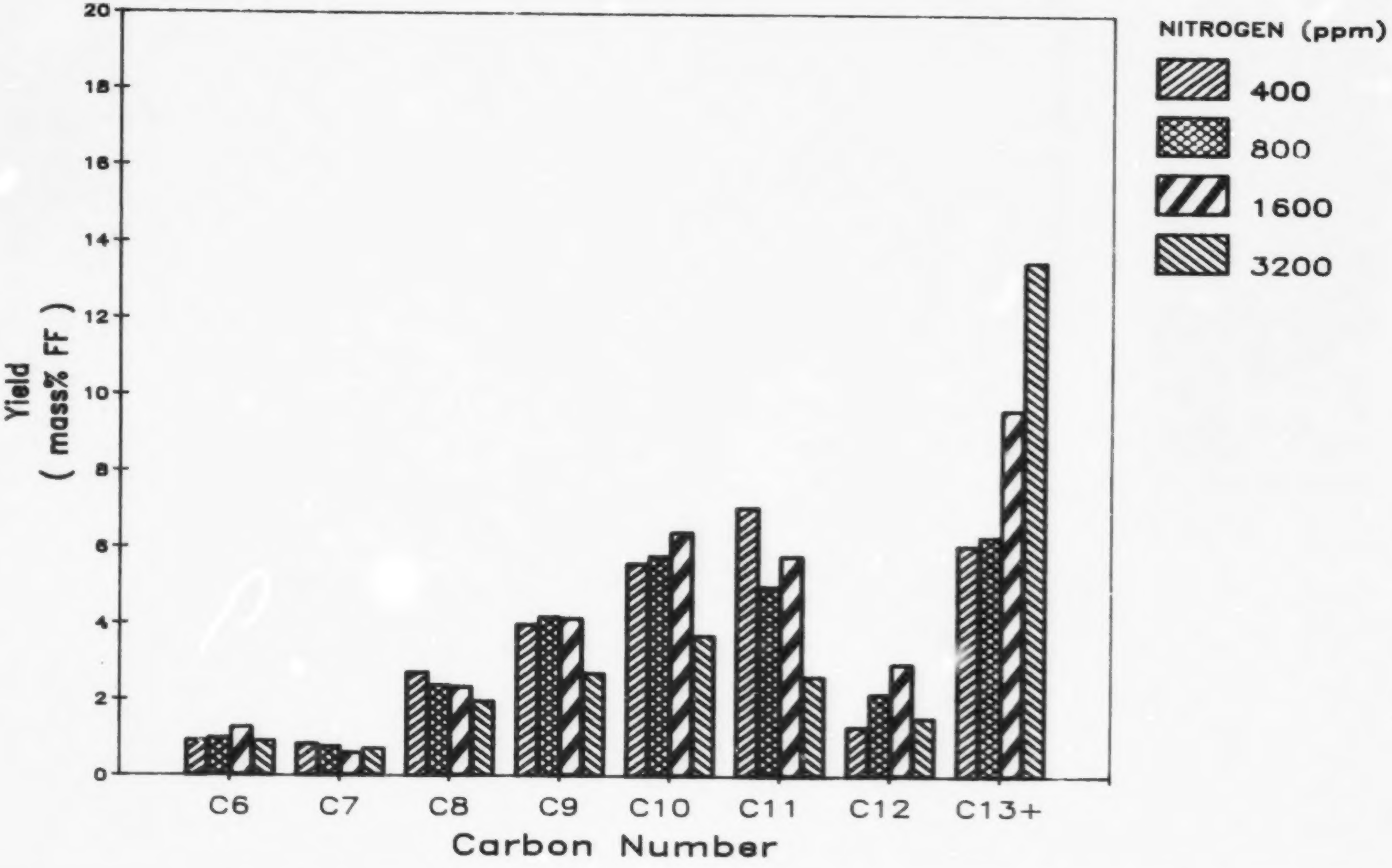


T3A0B

Task 3.A. Effects of Nitrogen Poisoning

AROMATIC DISTRIBUTION

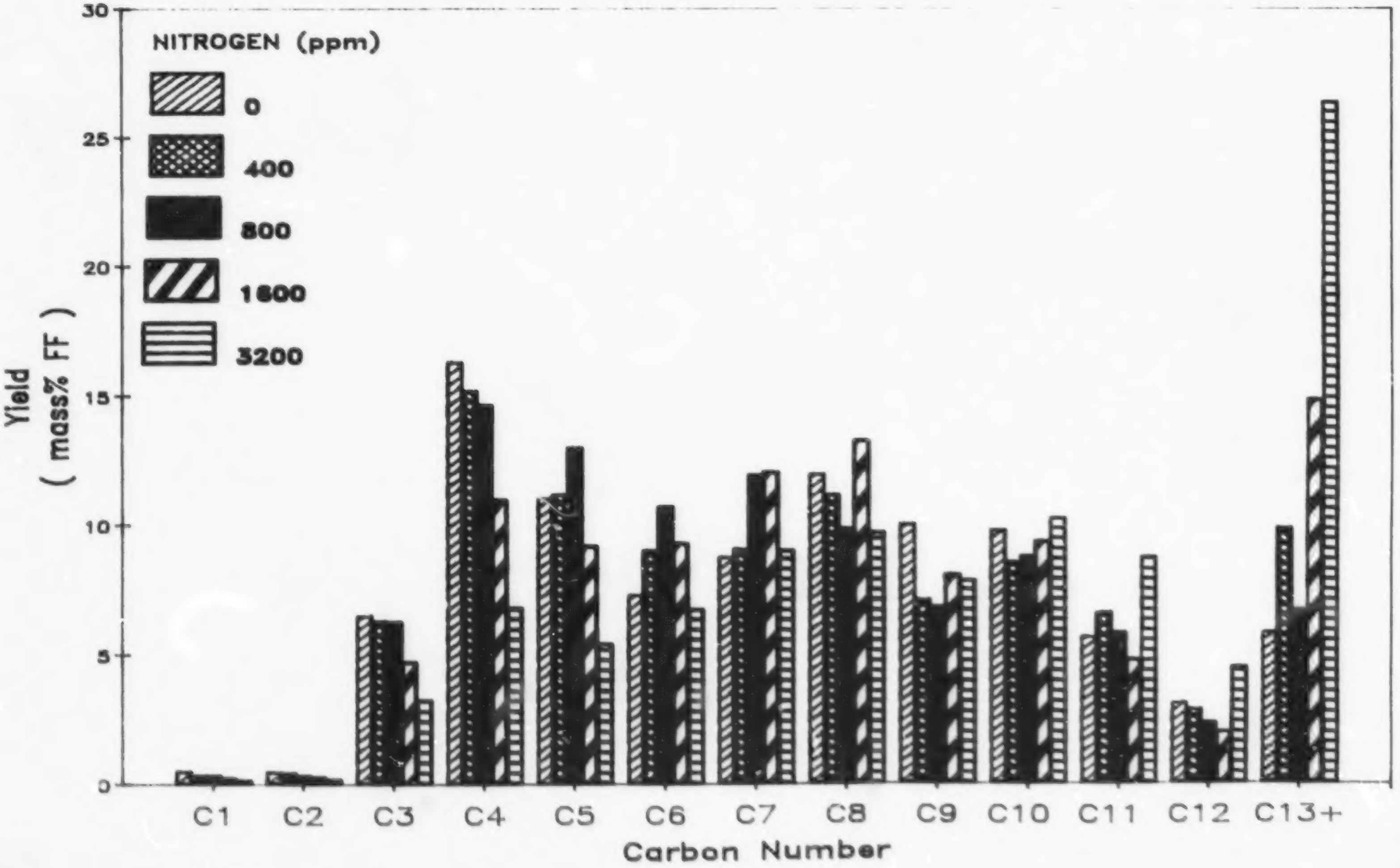
Blend B



Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

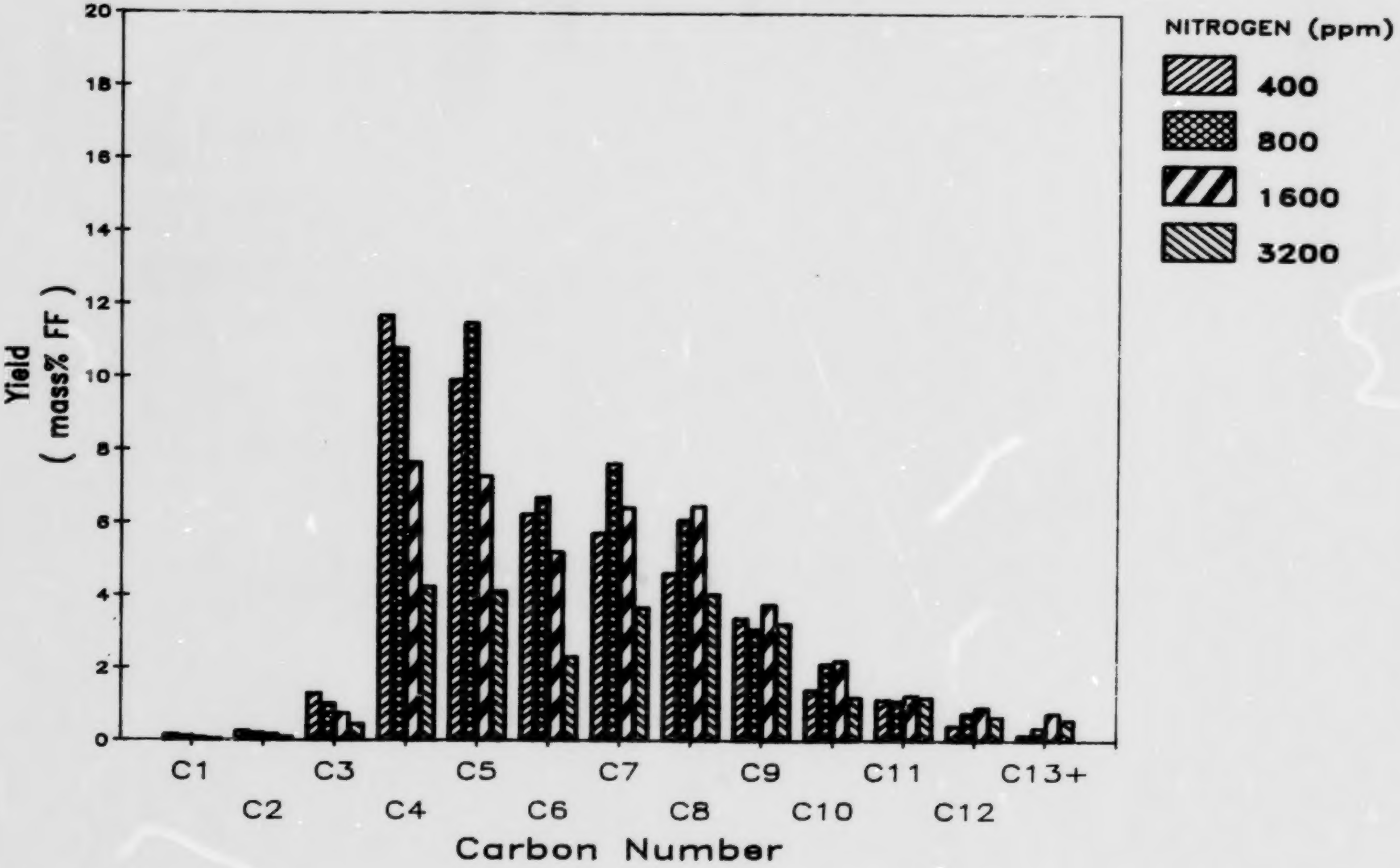
Blend C



T3ACCD

Task 3.A. Effects of Nitrogen Poisoning

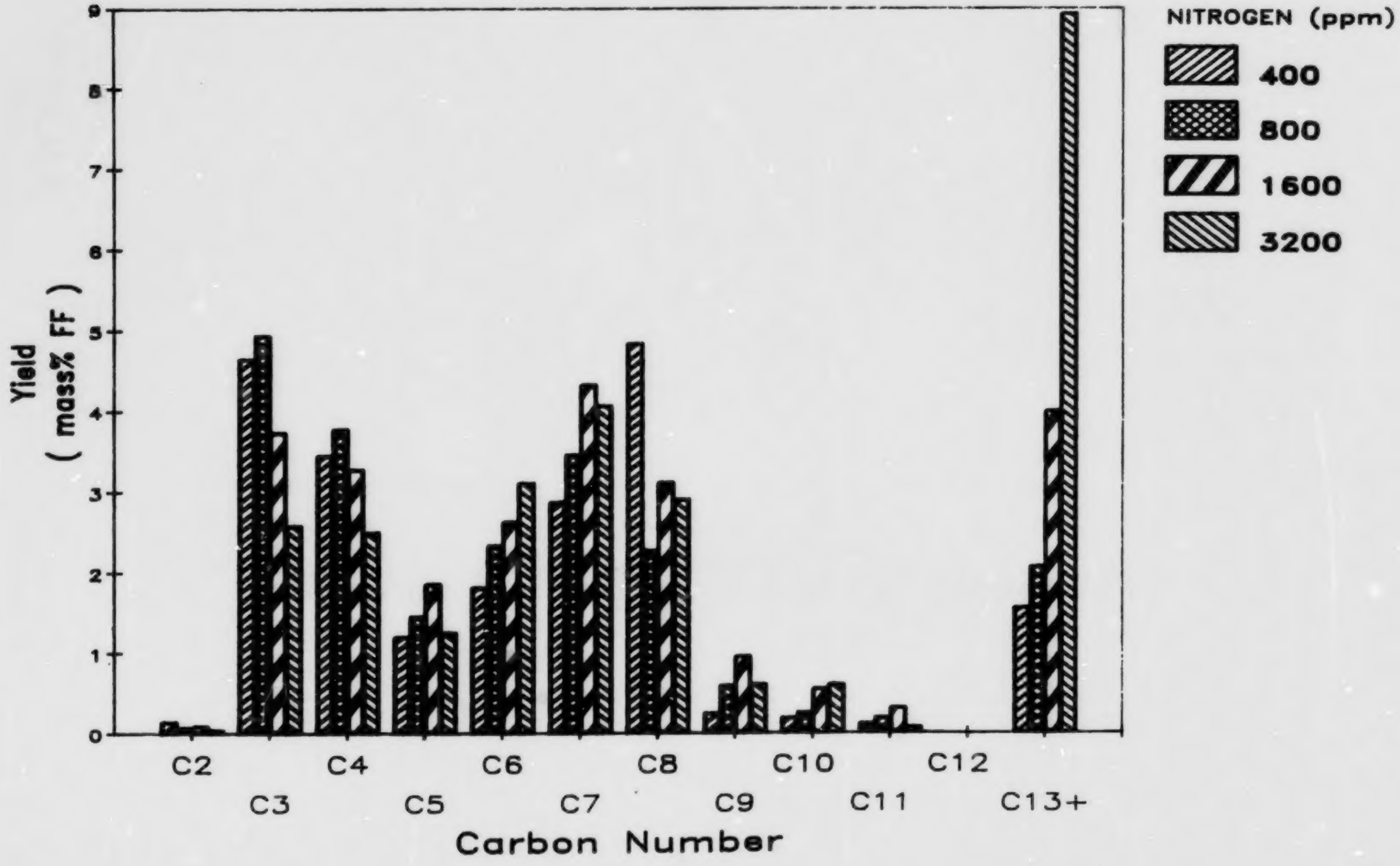
PARAFFIN DISTRIBUTION
Blend C



T3APC

Task 3.A. Effects of Nitrogen Poisoning

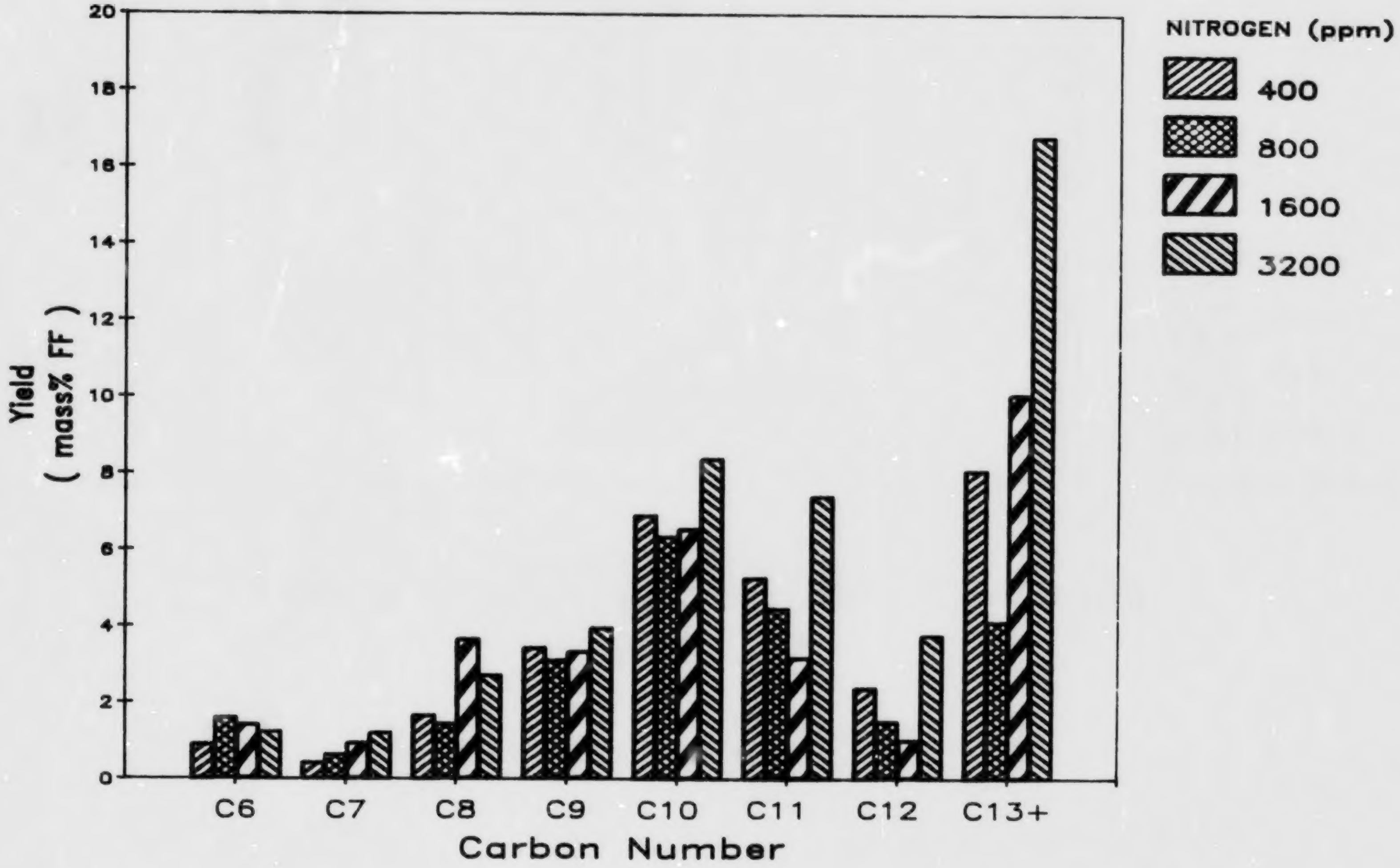
OLEFIN DISTRIBUTION
Blend C



T3AOC

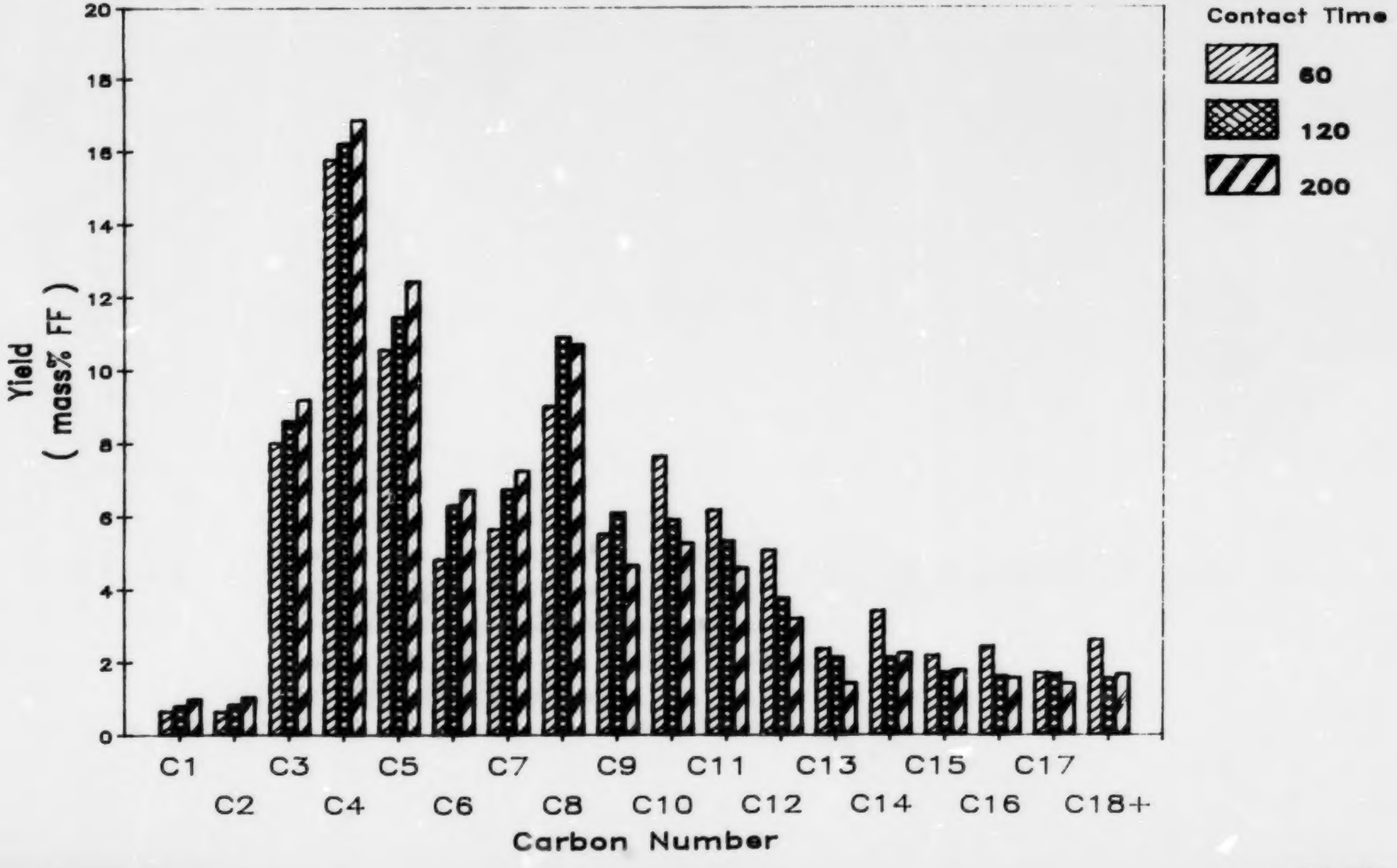
Task 3.A. Effects of Nitrogen Poisoning

AROMATIC DISTRIBUTION
Blend C



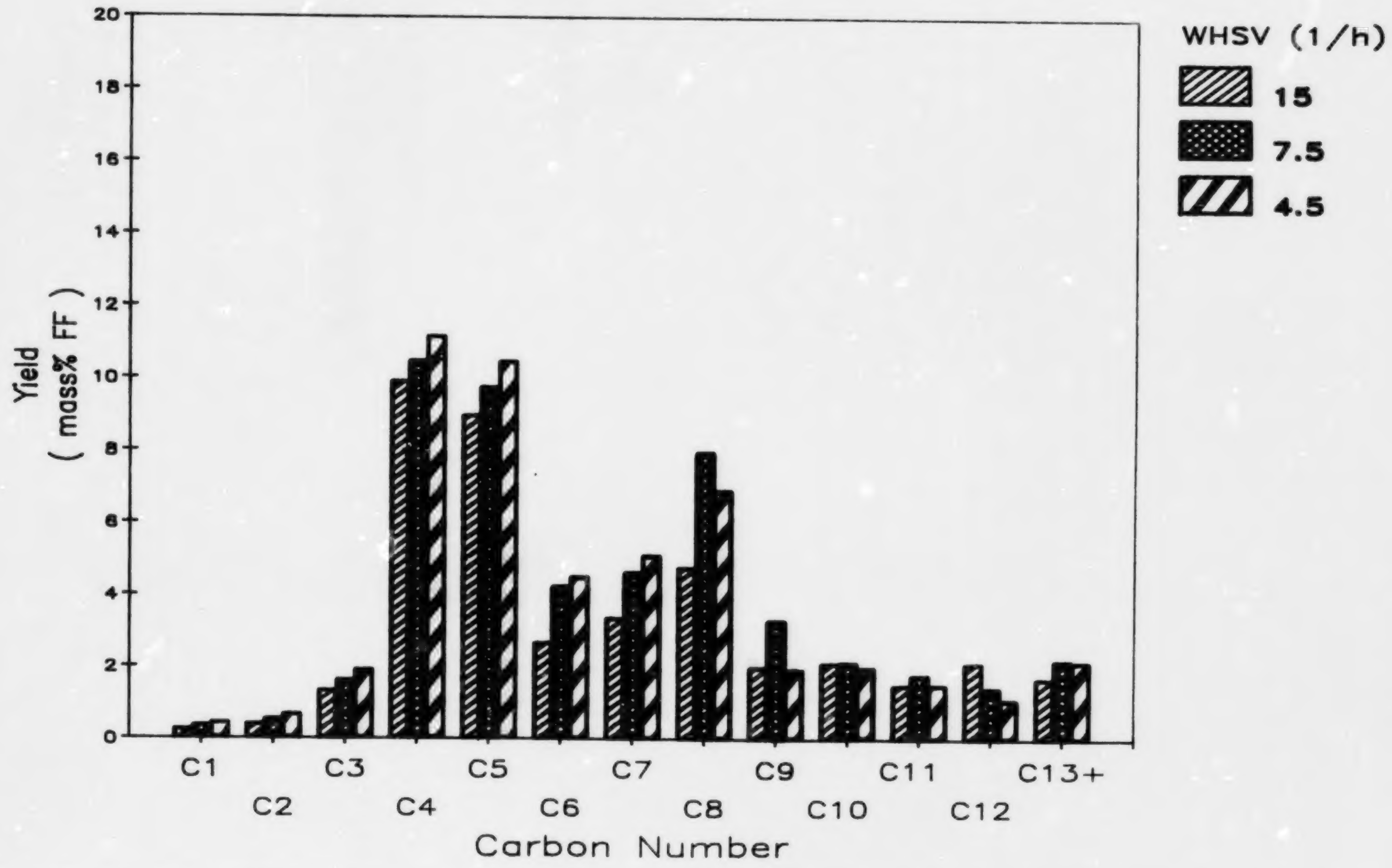
Task 4. Key Component Blends & Synergistic Effects

REACTOR EFFLUENT CARBON DISTRIBUTION
Blend A



Task 4. Key Component Blends & Synergistic Effects

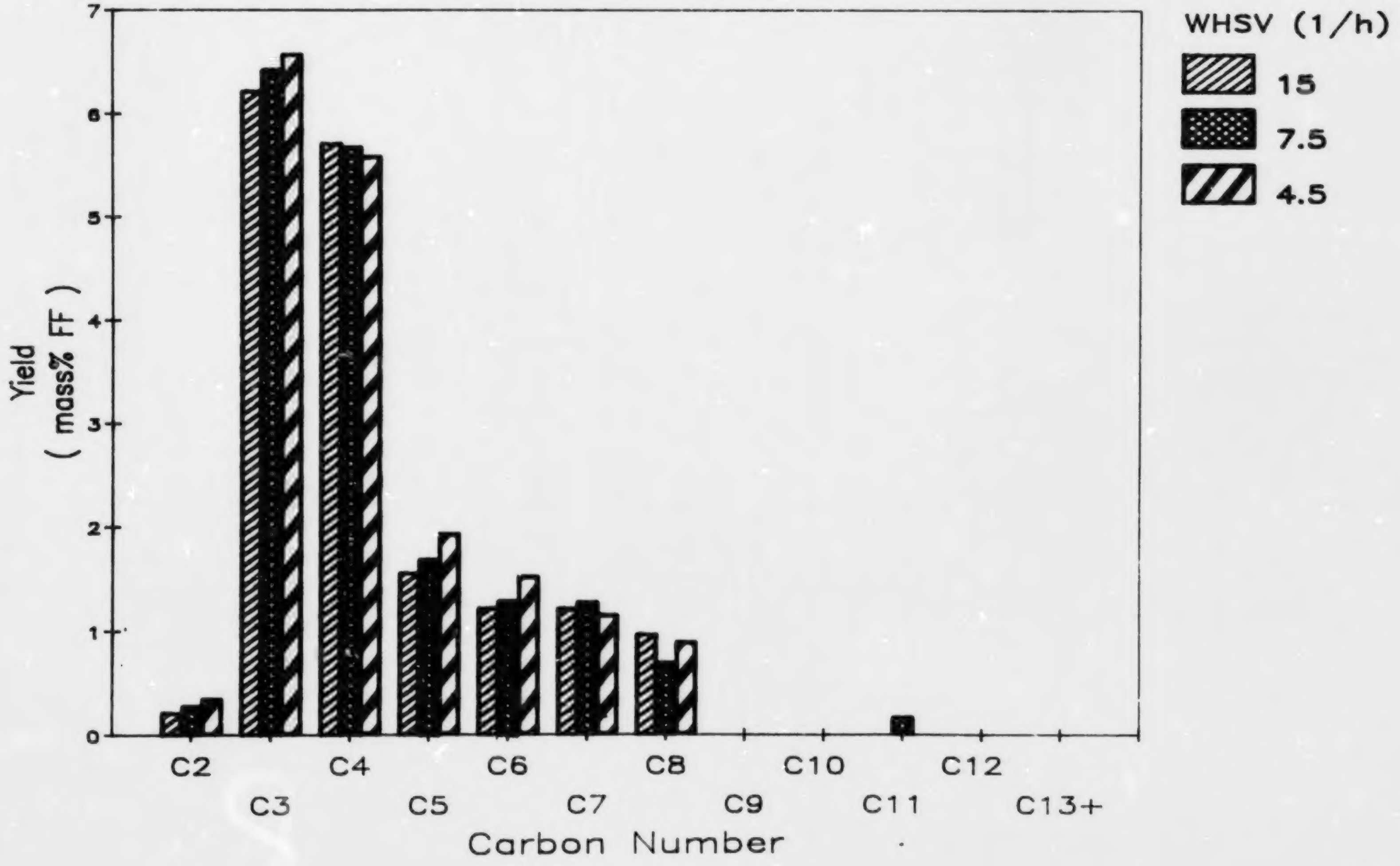
PARAFFIN DISTRIBUTION
Blend A



Task 4. Key Component Blends & Synergistic Effects

OLEFIN DISTRIBUTION

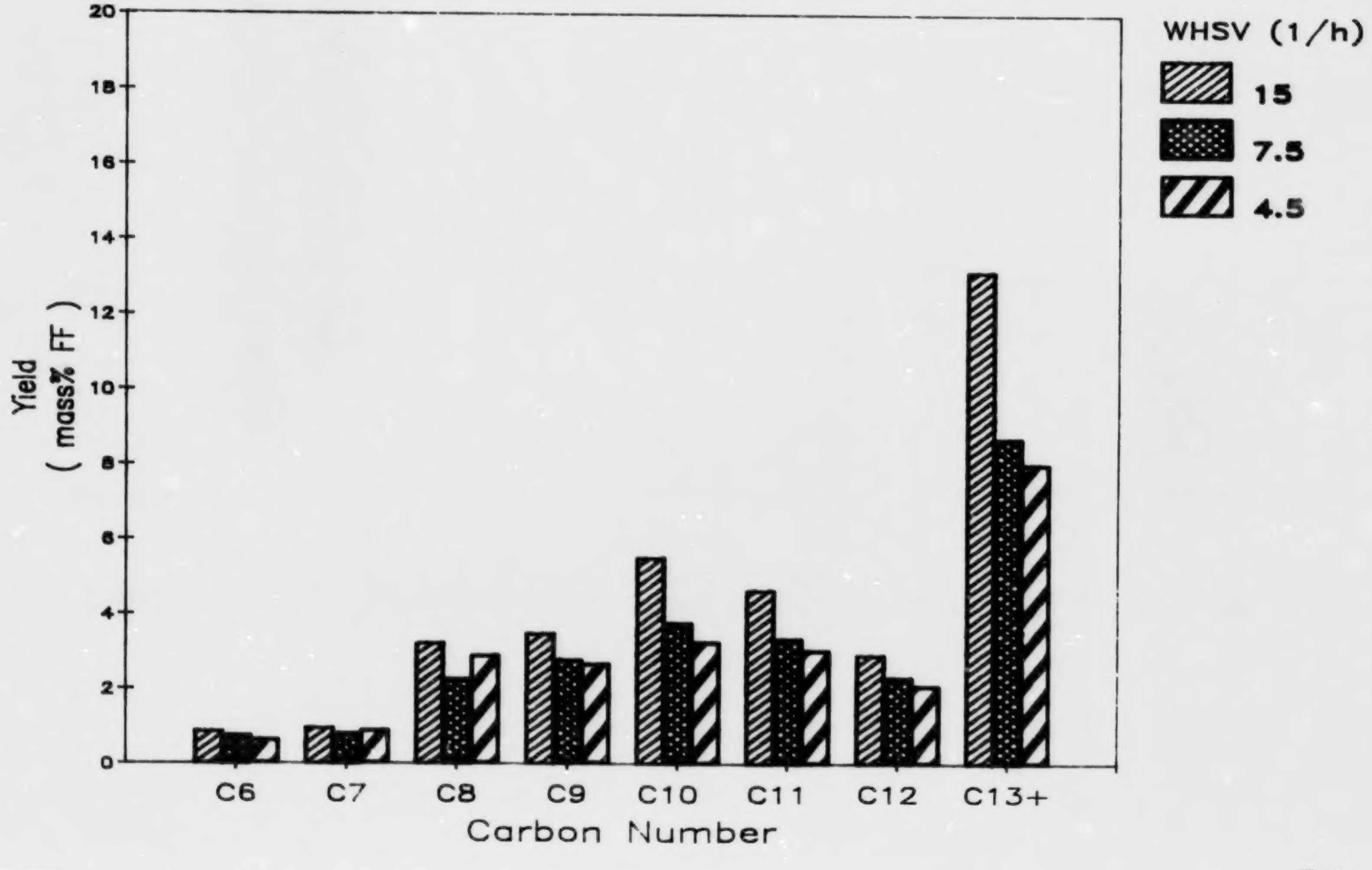
Blend A



T40A

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION
Blend A

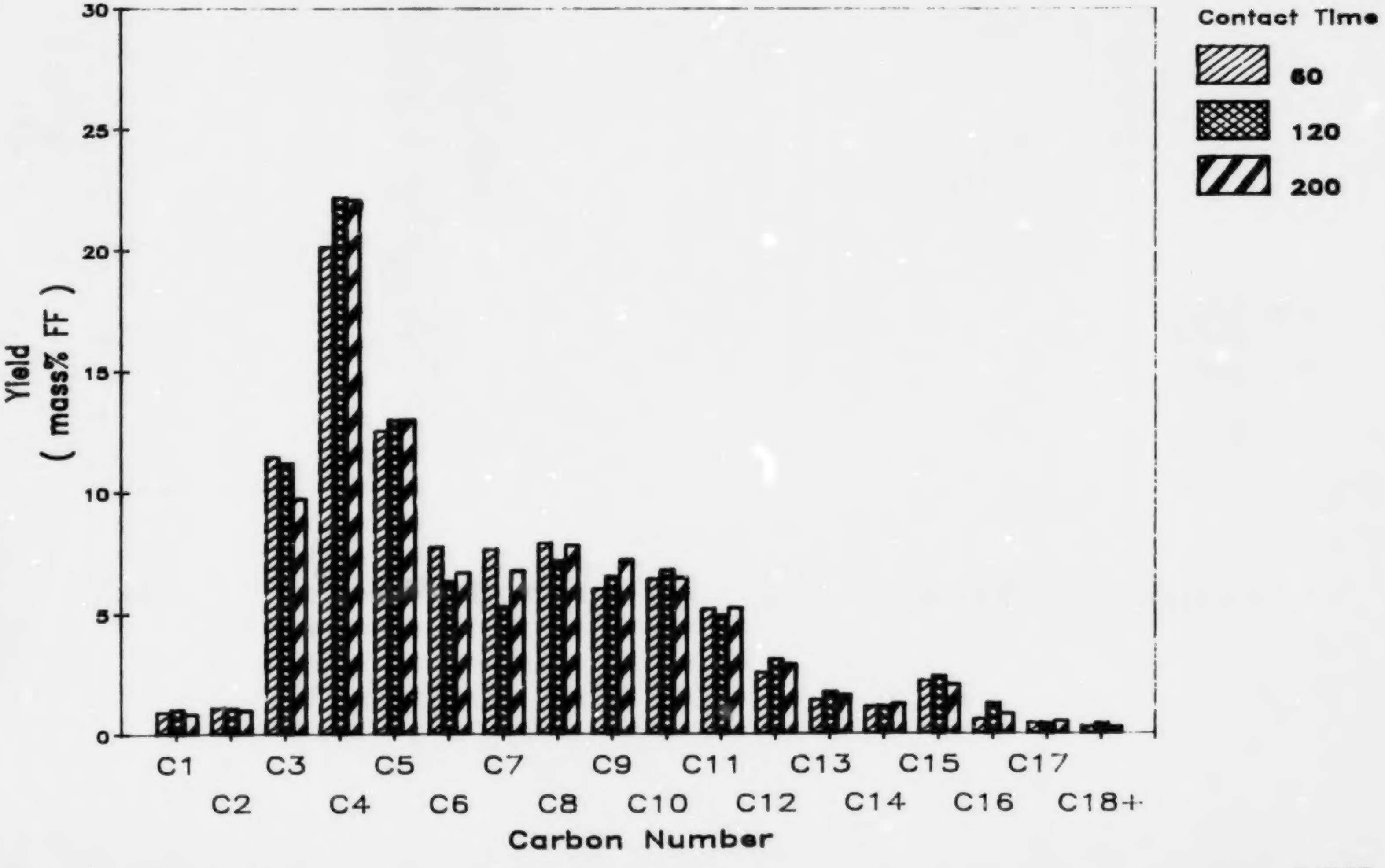


T4AA

Task 4. Key Component Blends & Synergistic Effects

REACTOR EFFLUENT CARBON DISTRIBUTION

Blend B

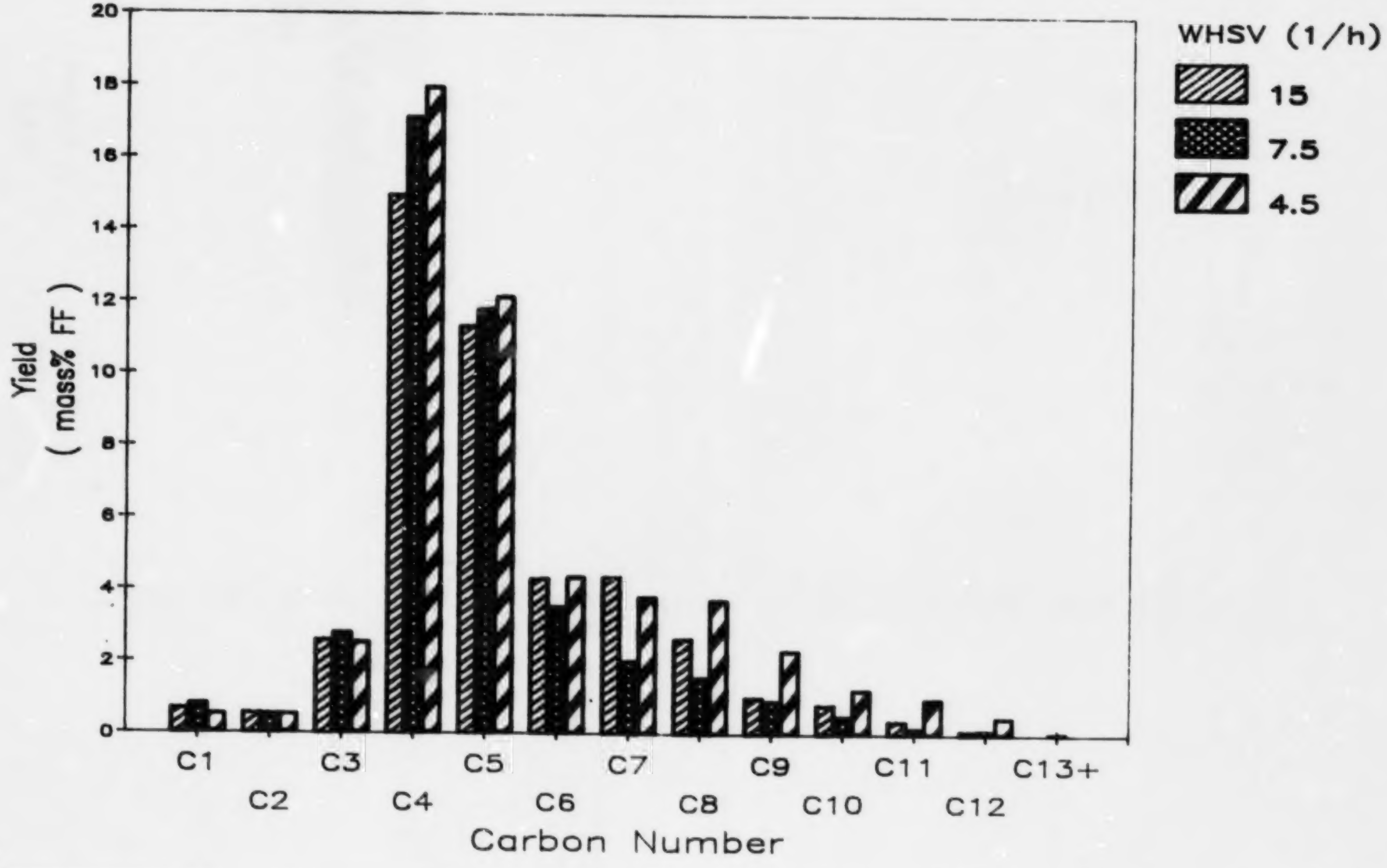


T4BCD

Task 4. Key Component Blends & Synergistic Effects

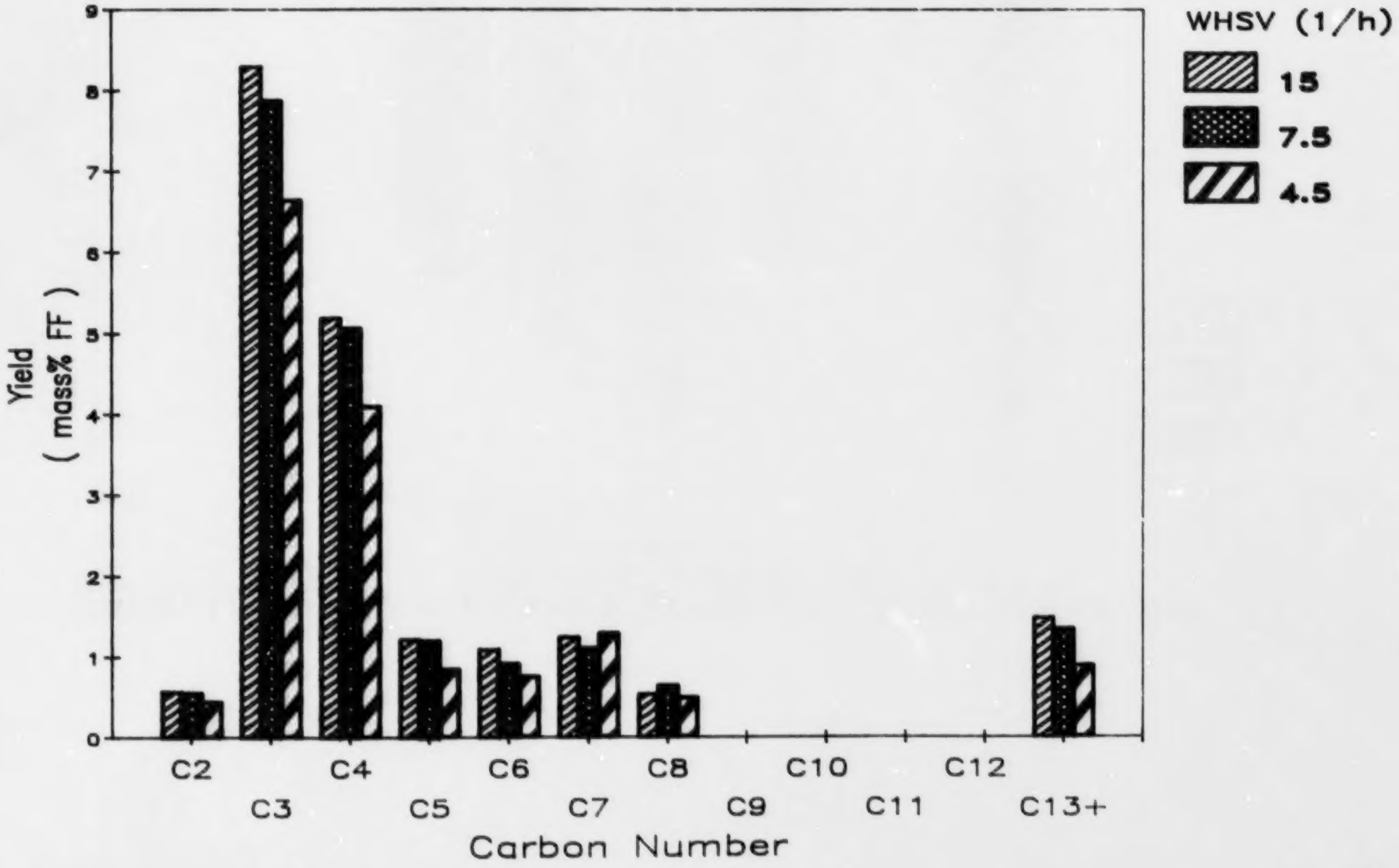
PARAFFIN DISTRIBUTION

Blend B



Task 4. Key Component Blends & Synergistic Effects

OLEFIN DISTRIBUTION
Blend B

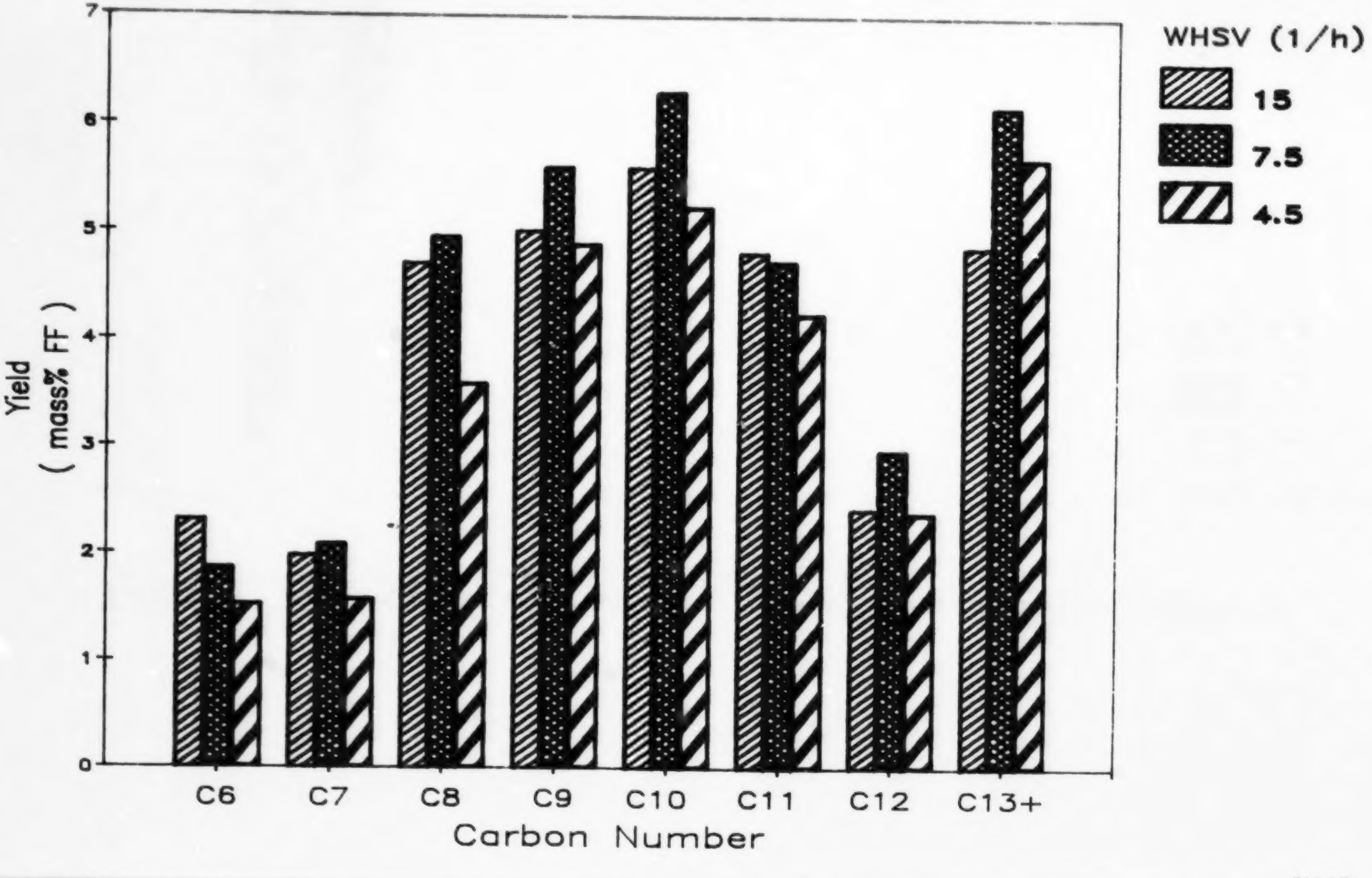


T40B

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION

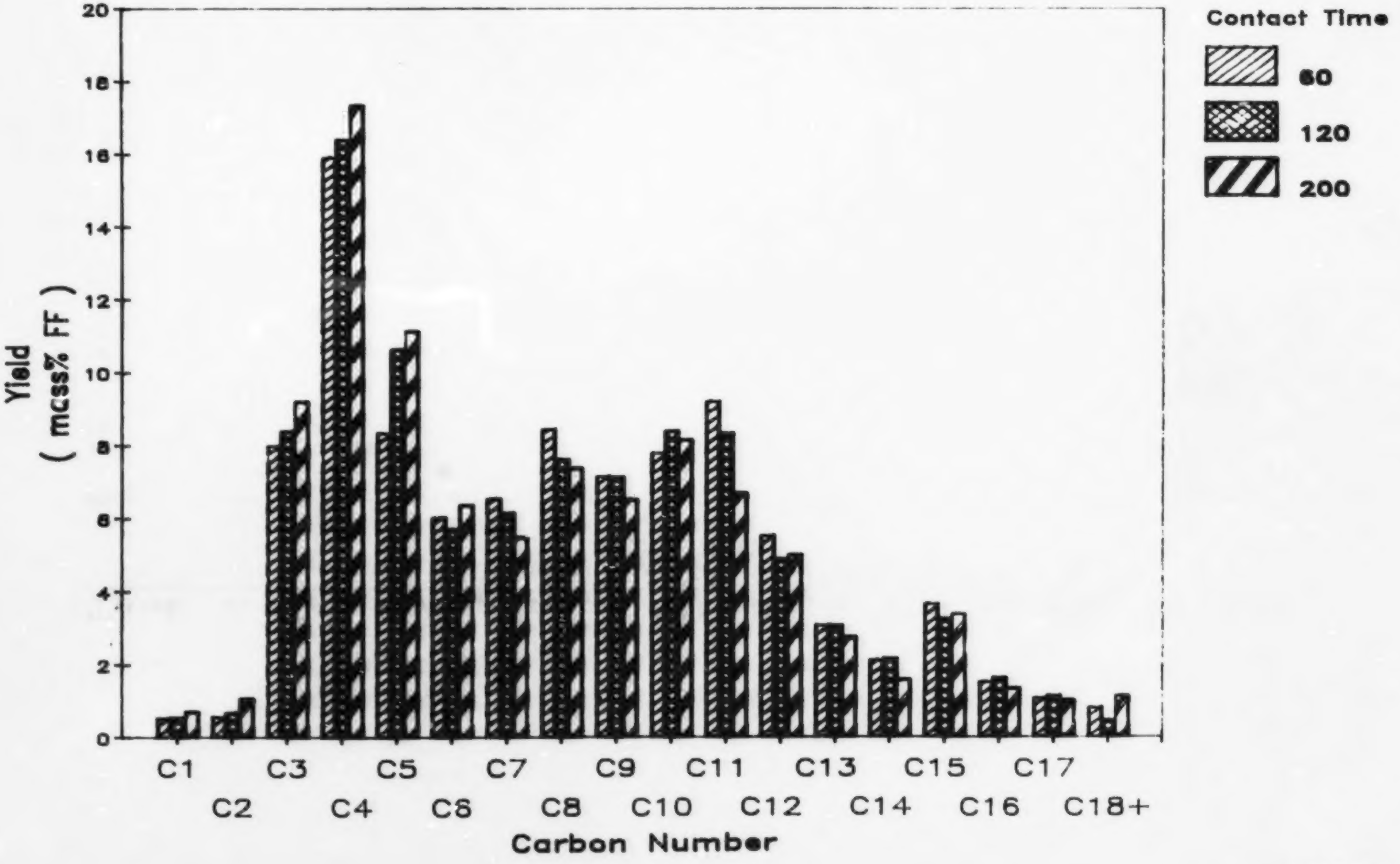
Blend B



Task 4. Key Component Blends & Synergistic Effects

REACTOR EFFLUENT CARBON DISTRIBUTION

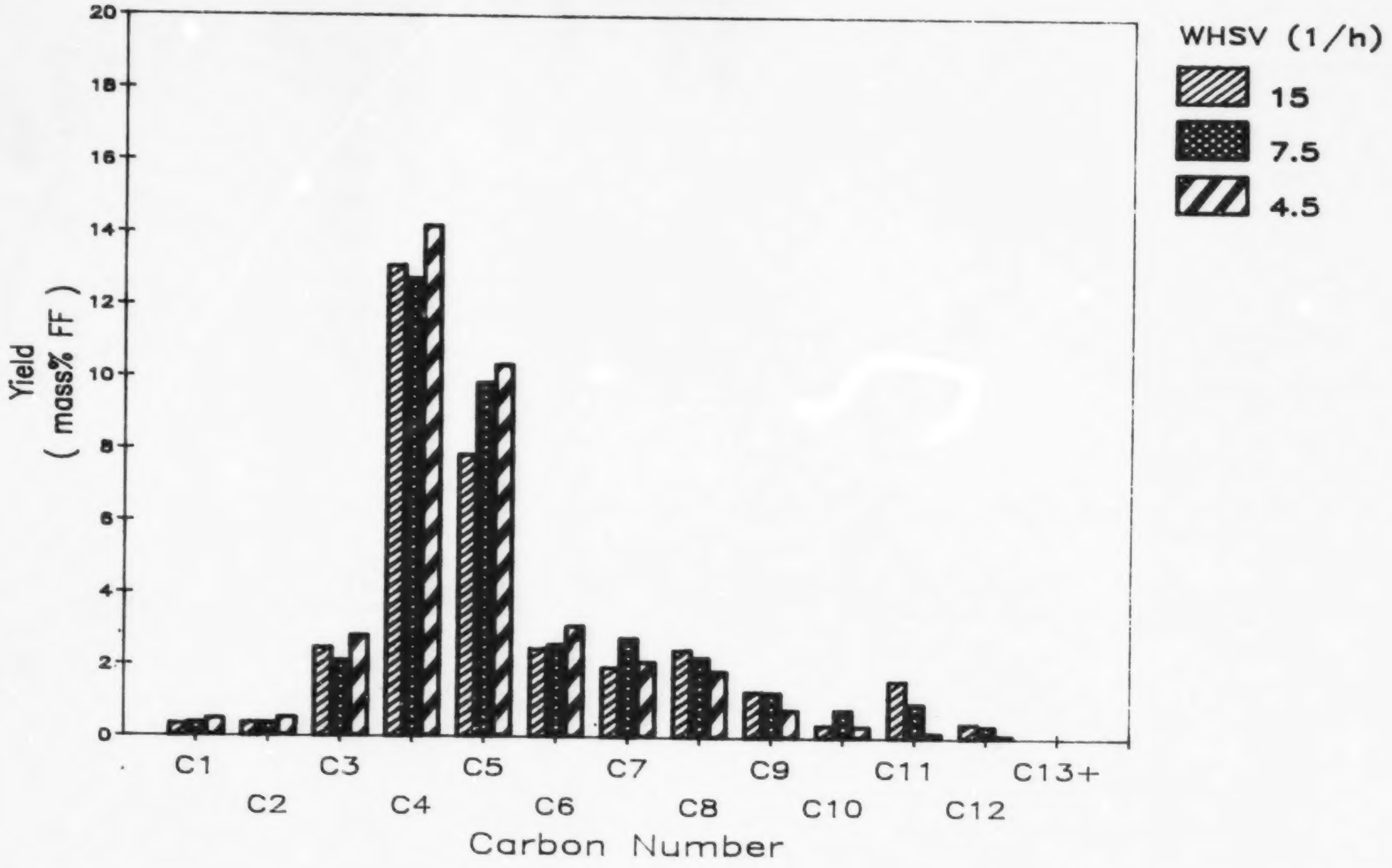
Blend C



T4CCD

Task 4. Key Component Blends & Synergistic Effects

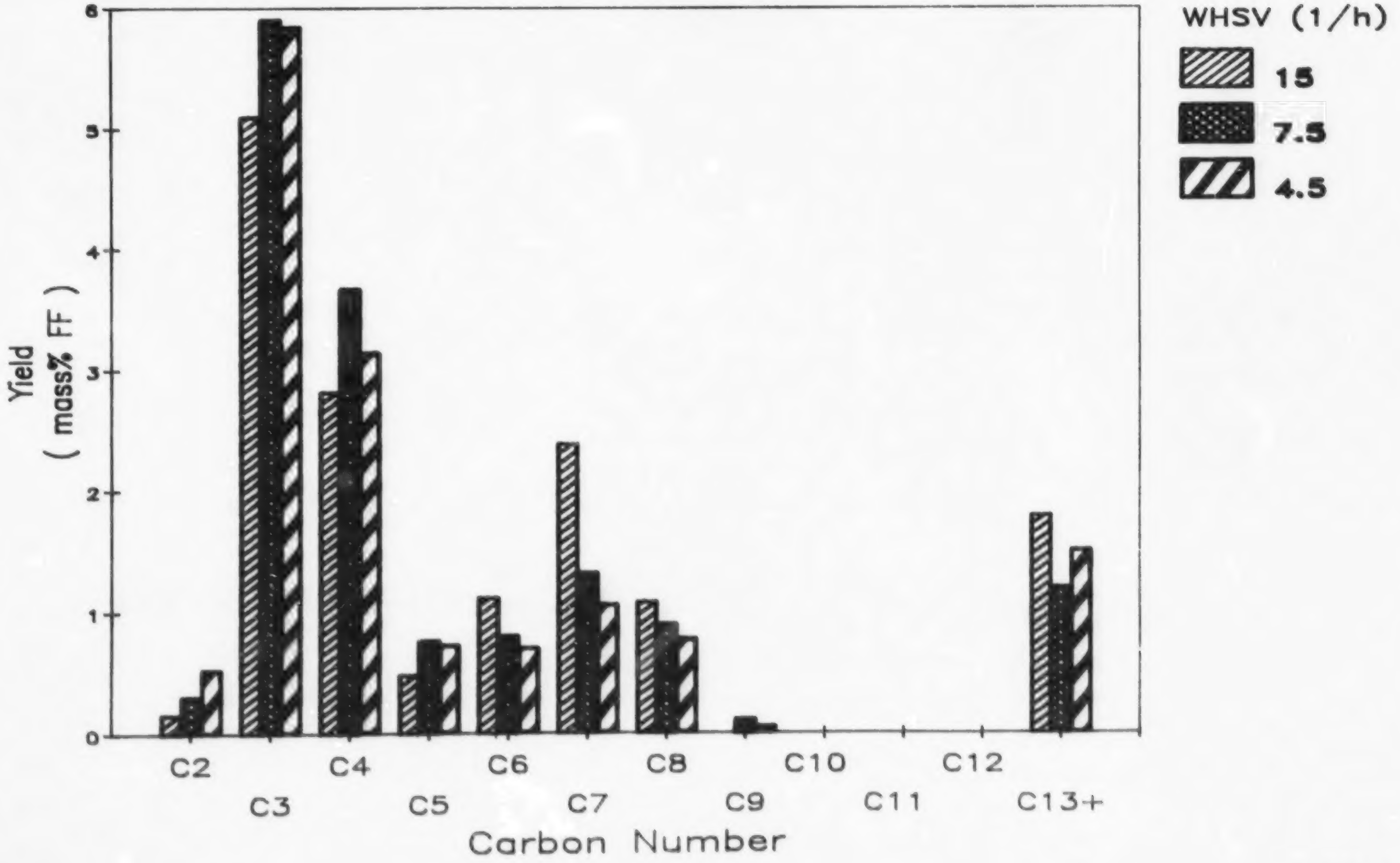
PARAFFIN DISTRIBUTION
Blend C



T4PC

Task 4. Key Component Blends & Synergistic Effects

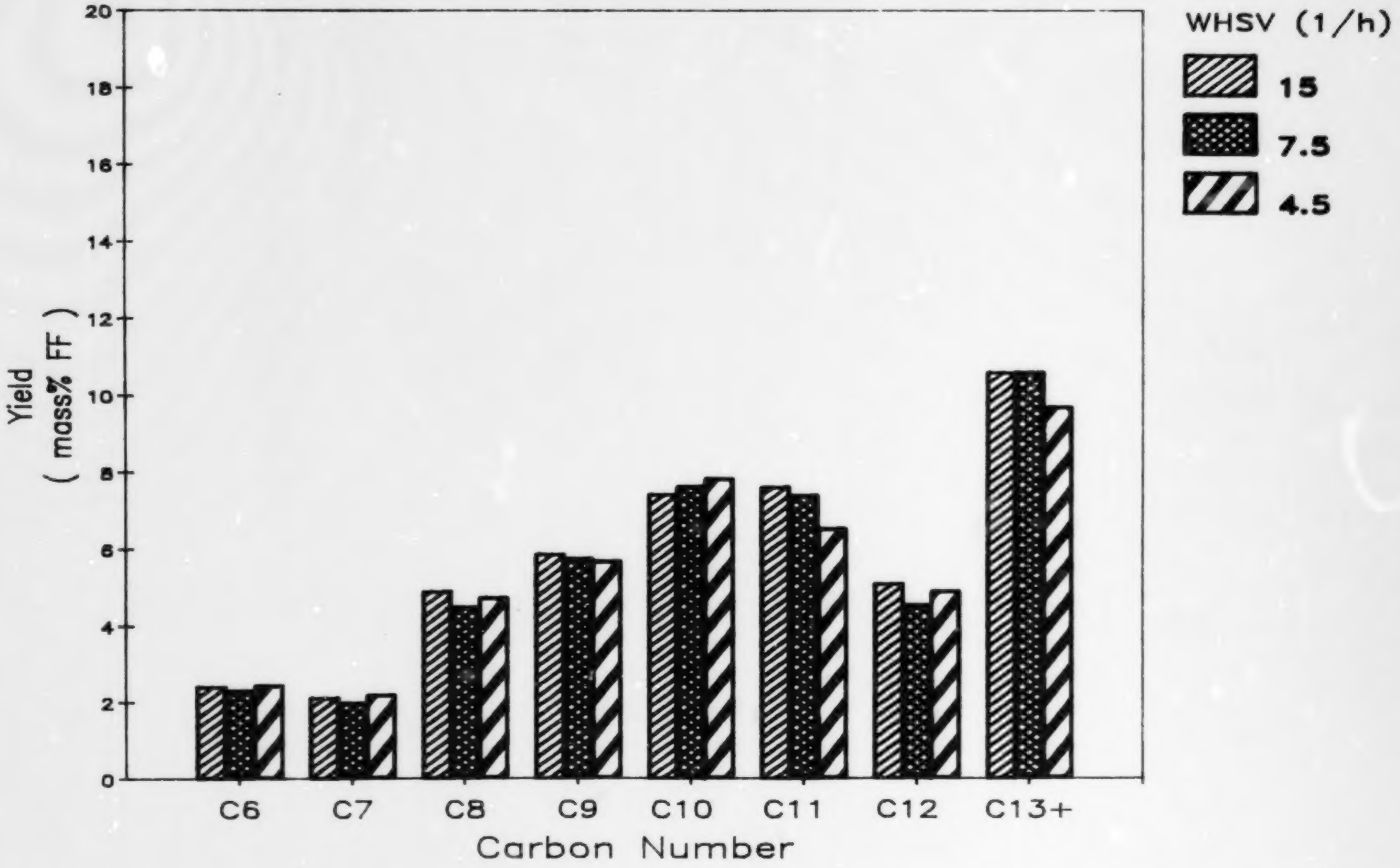
OLEFIN DISTRIBUTION
Blend C



T40C

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION
Blend C

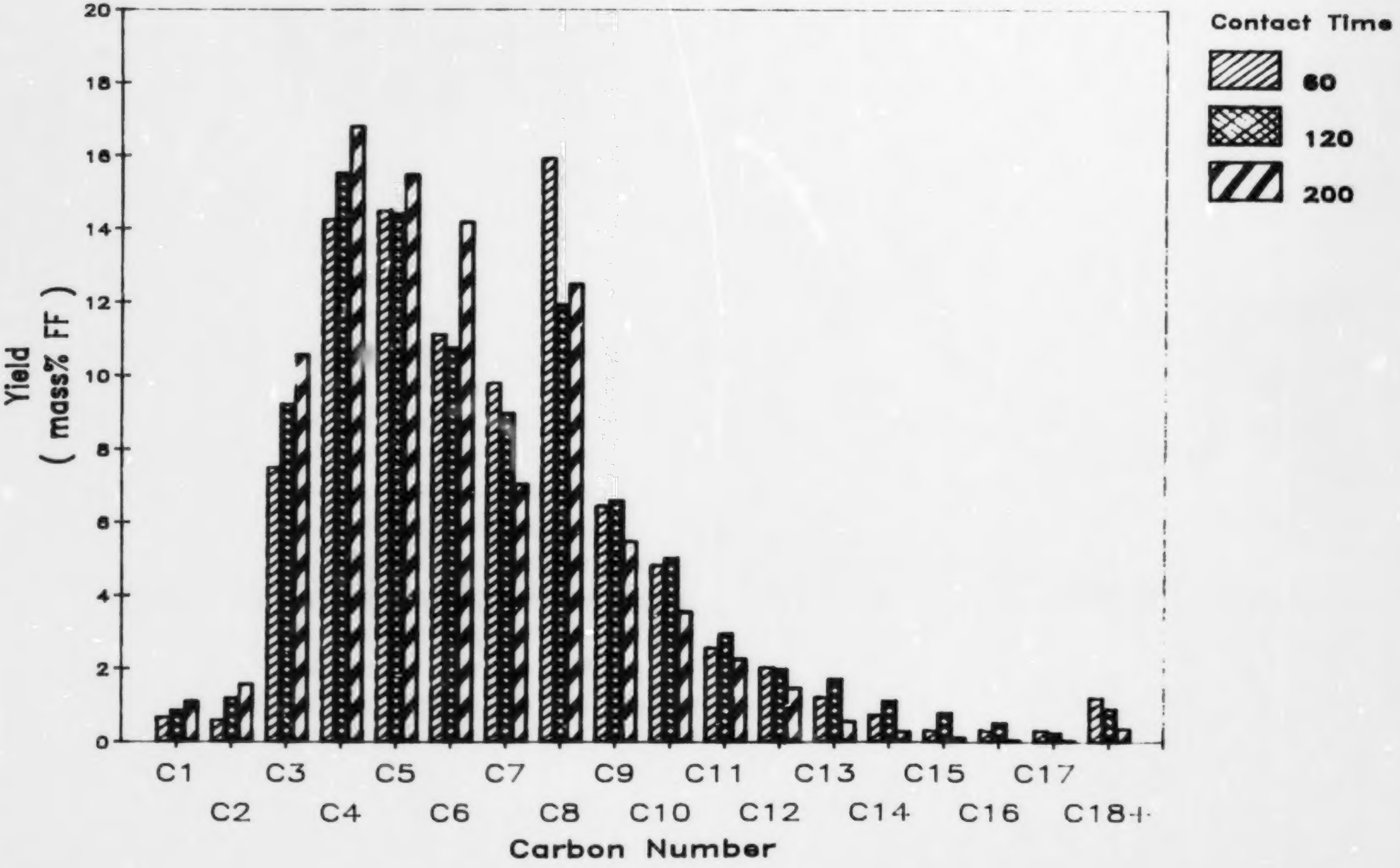


T4AC

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

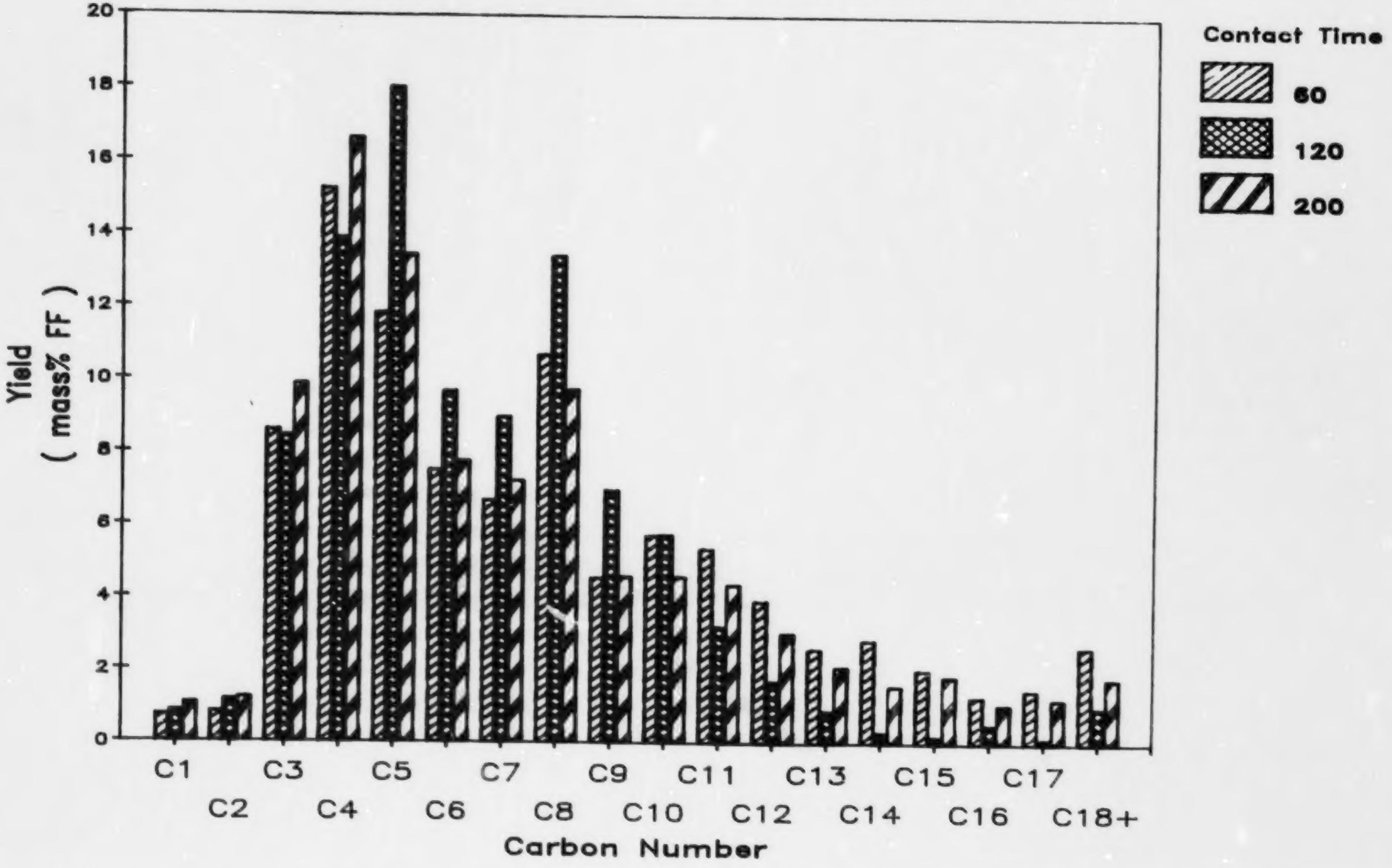
Feed : Blend A   Catalyst : 0.11% CRC



T5A11CD

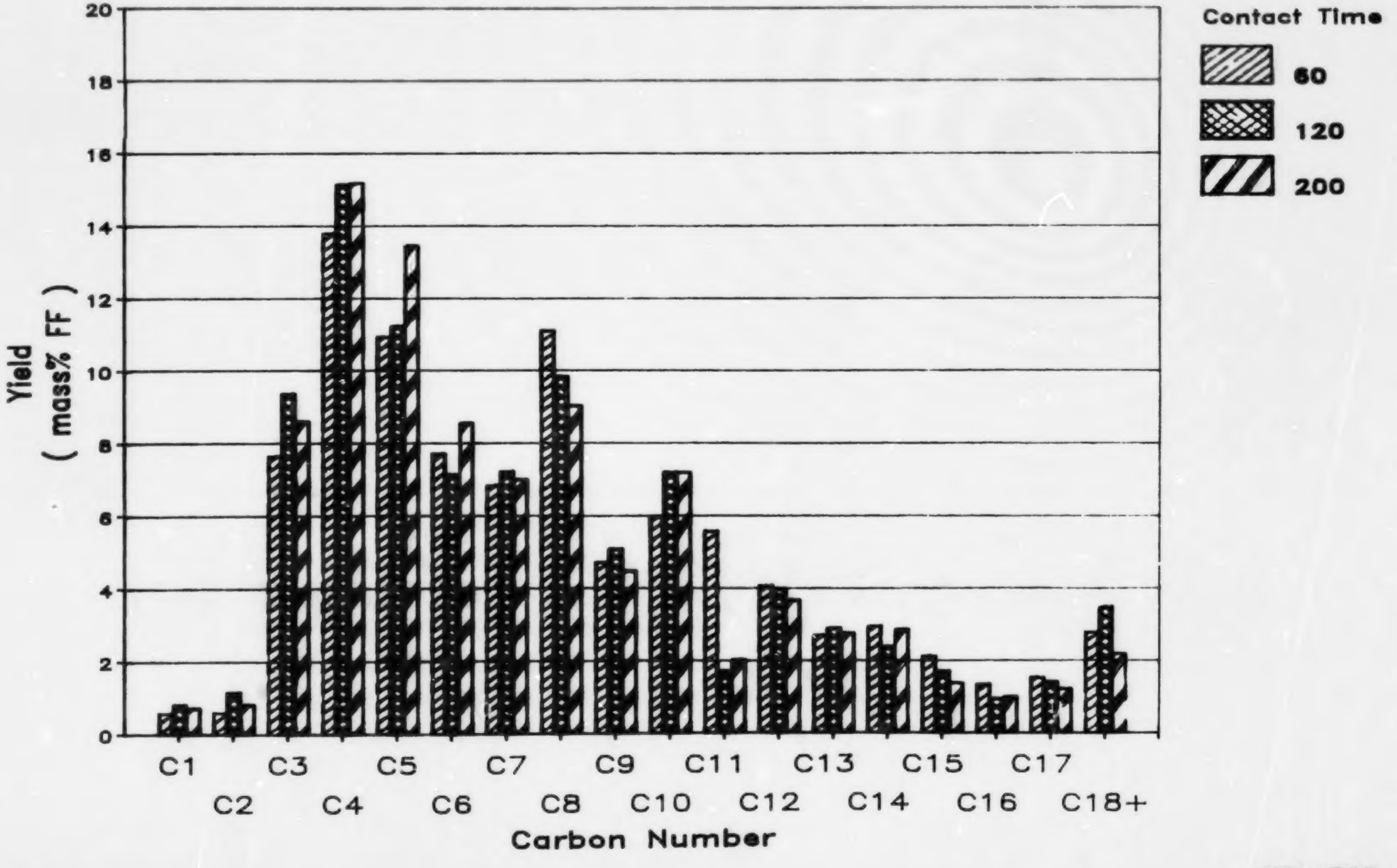
Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend A   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend A   Catalyst : 0.48% CRC

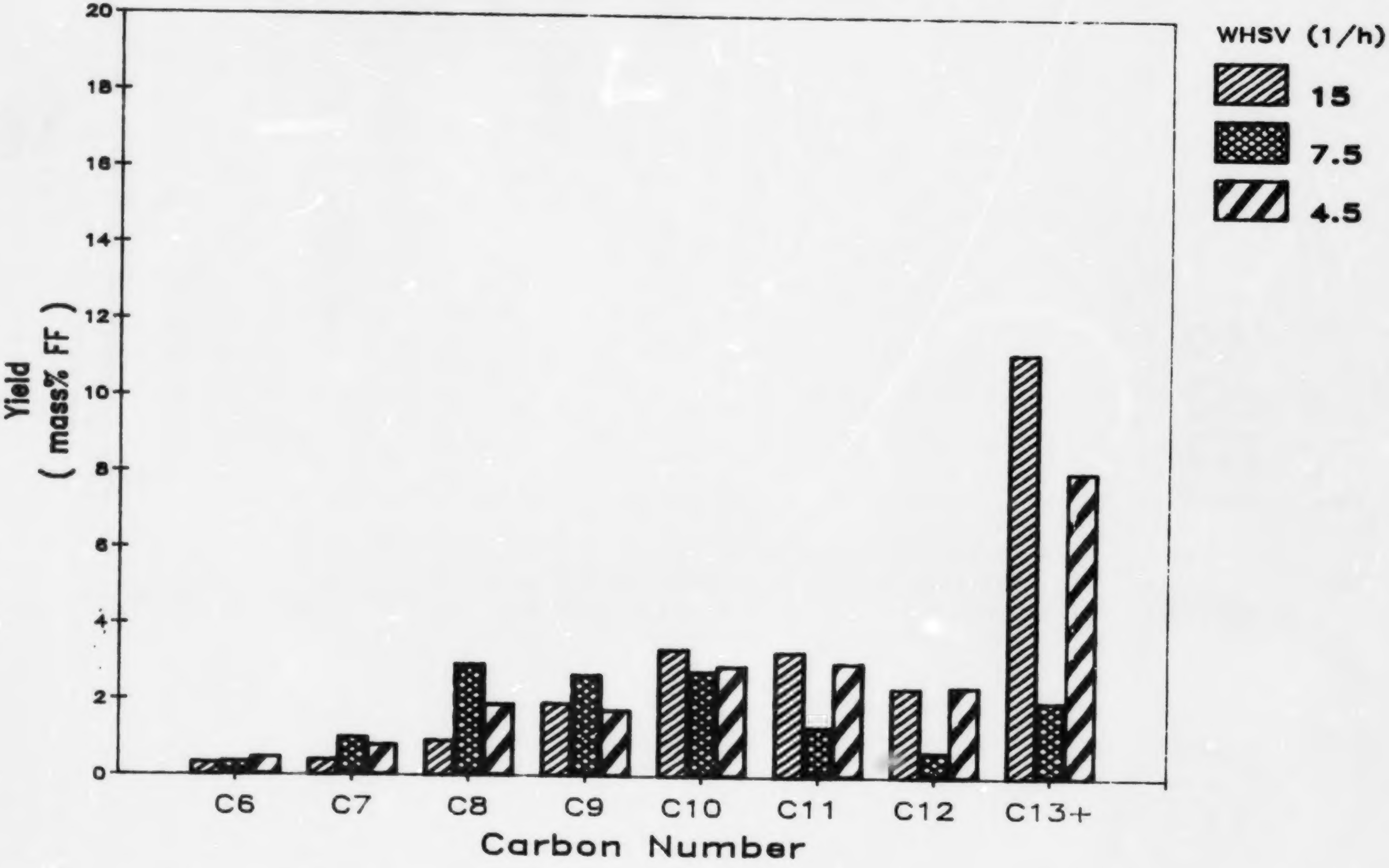


T5A48CD

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

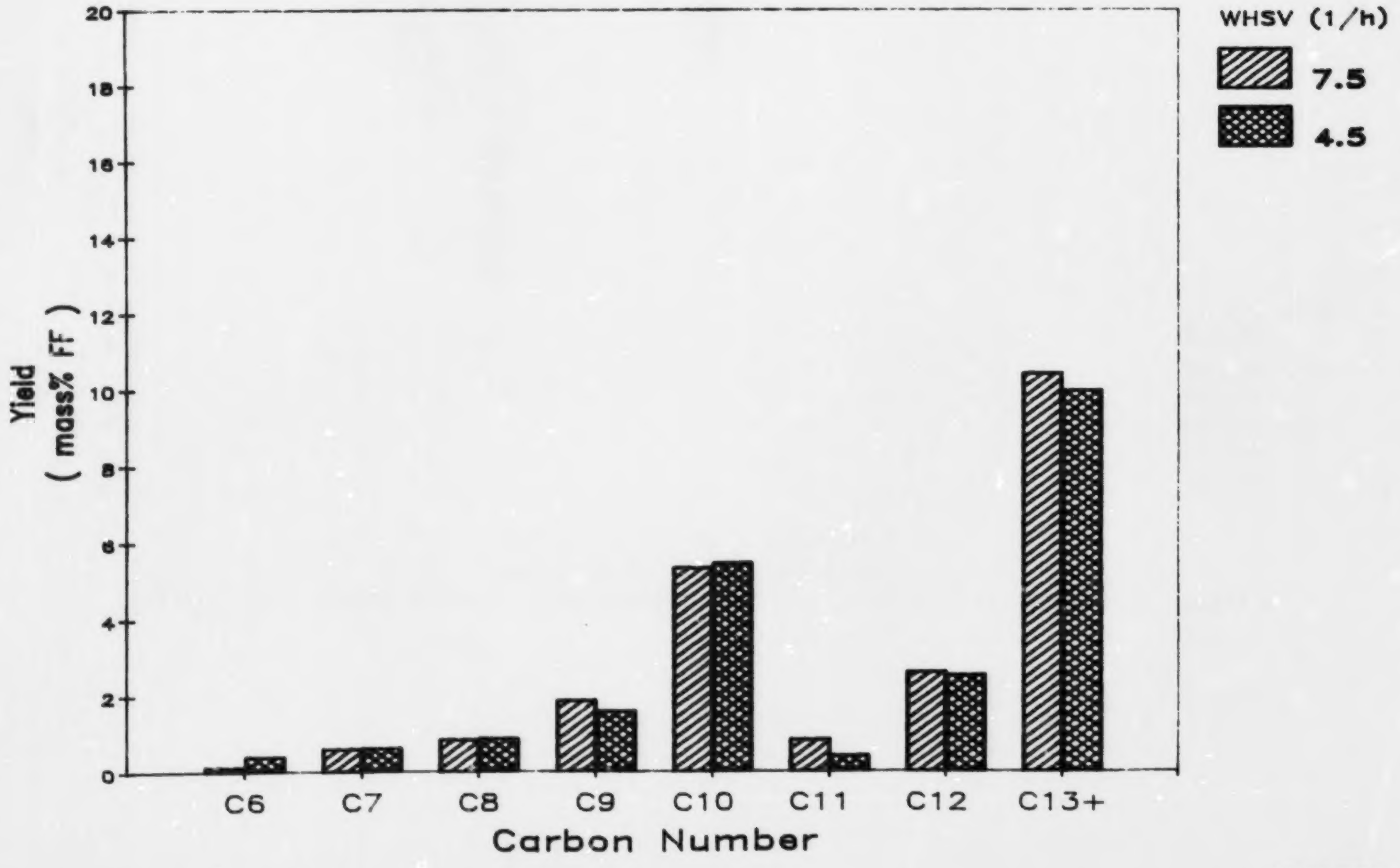
Feed : Blend A   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

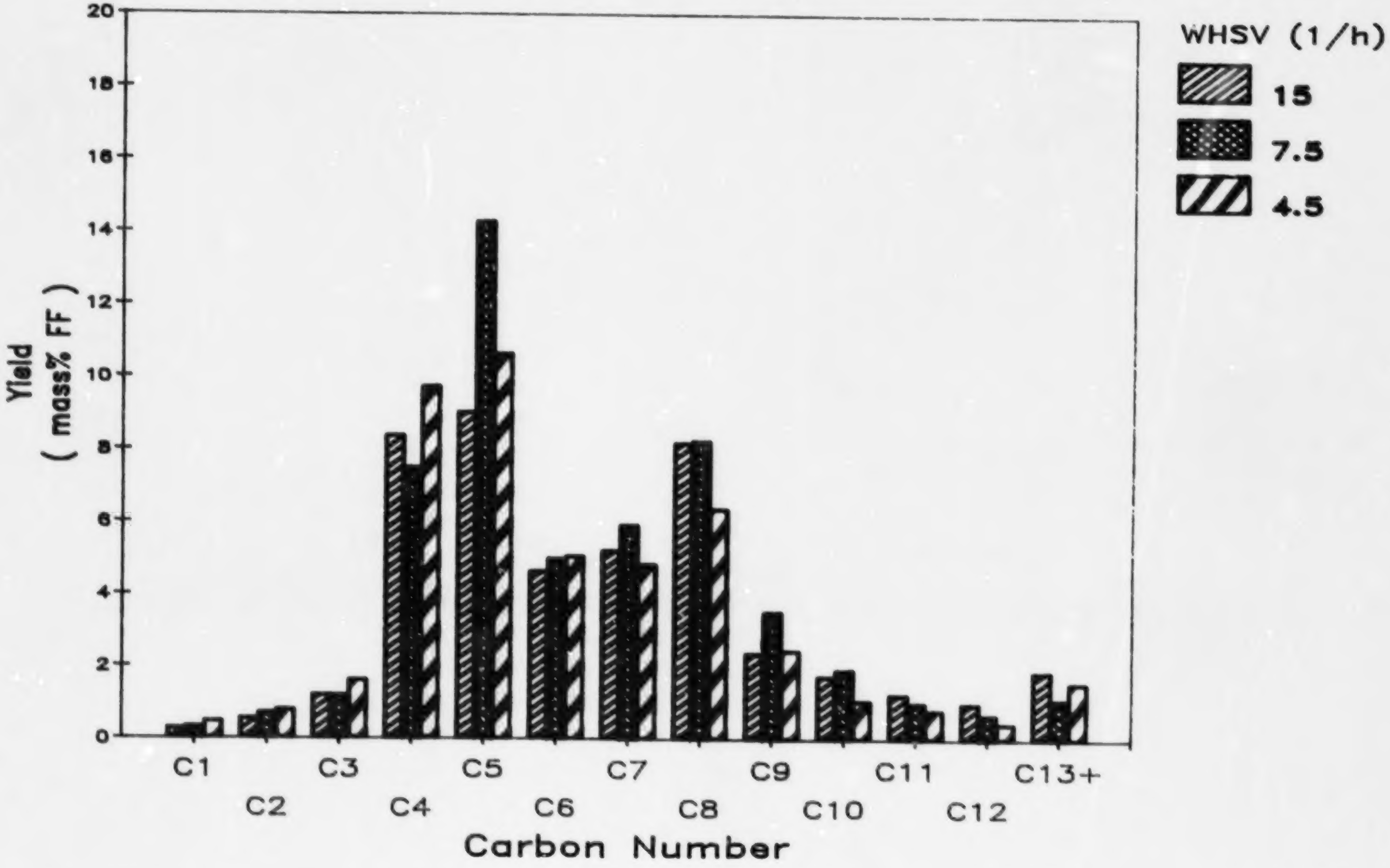
Feed : Blend A   Catalyst : 0.48% CRC



T5AA27C

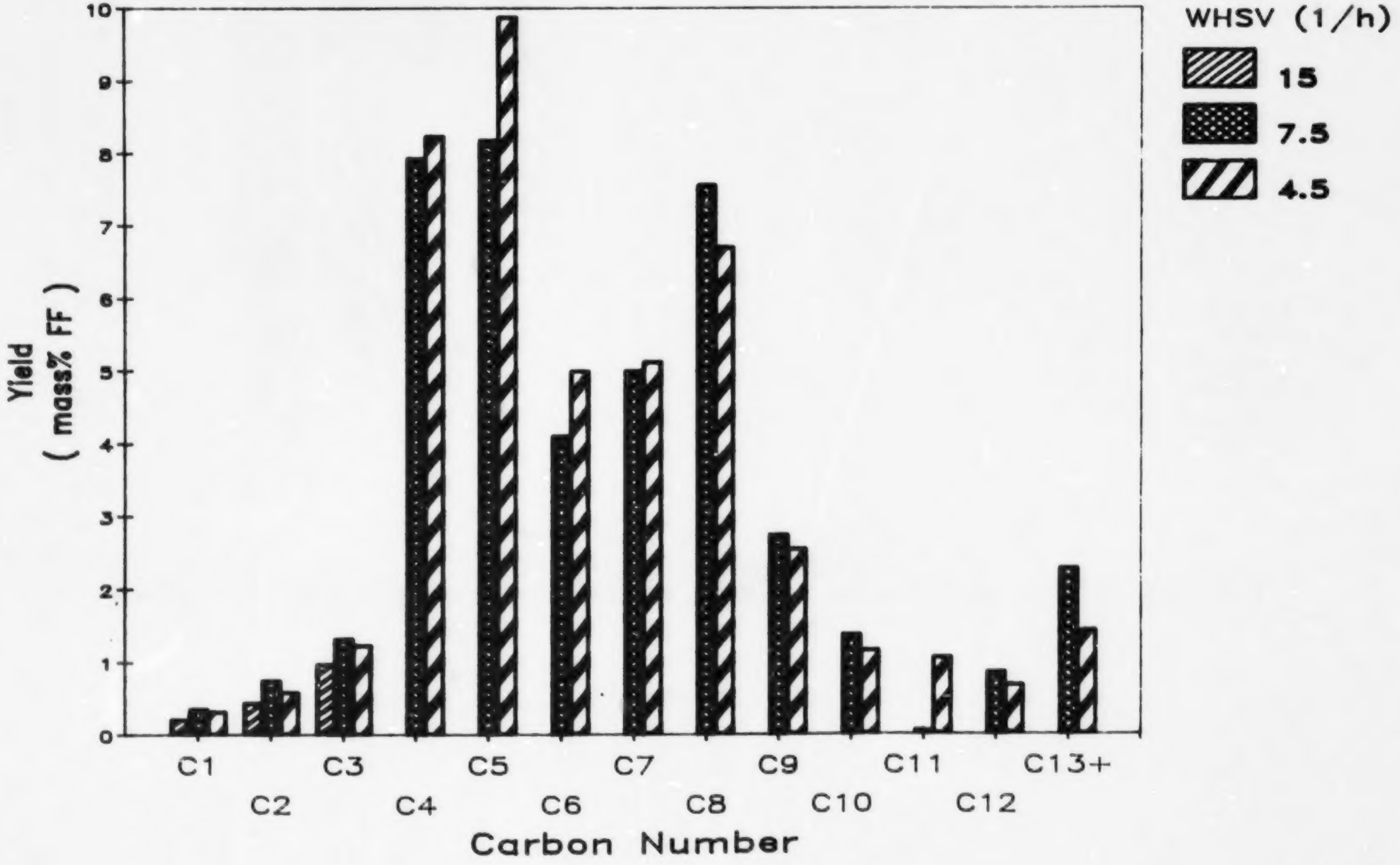
Task 5. Residual Catalyst Coke on Cracking Yields

PARAFFIN DISTRIBUTION
Blend A -- 0.27% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

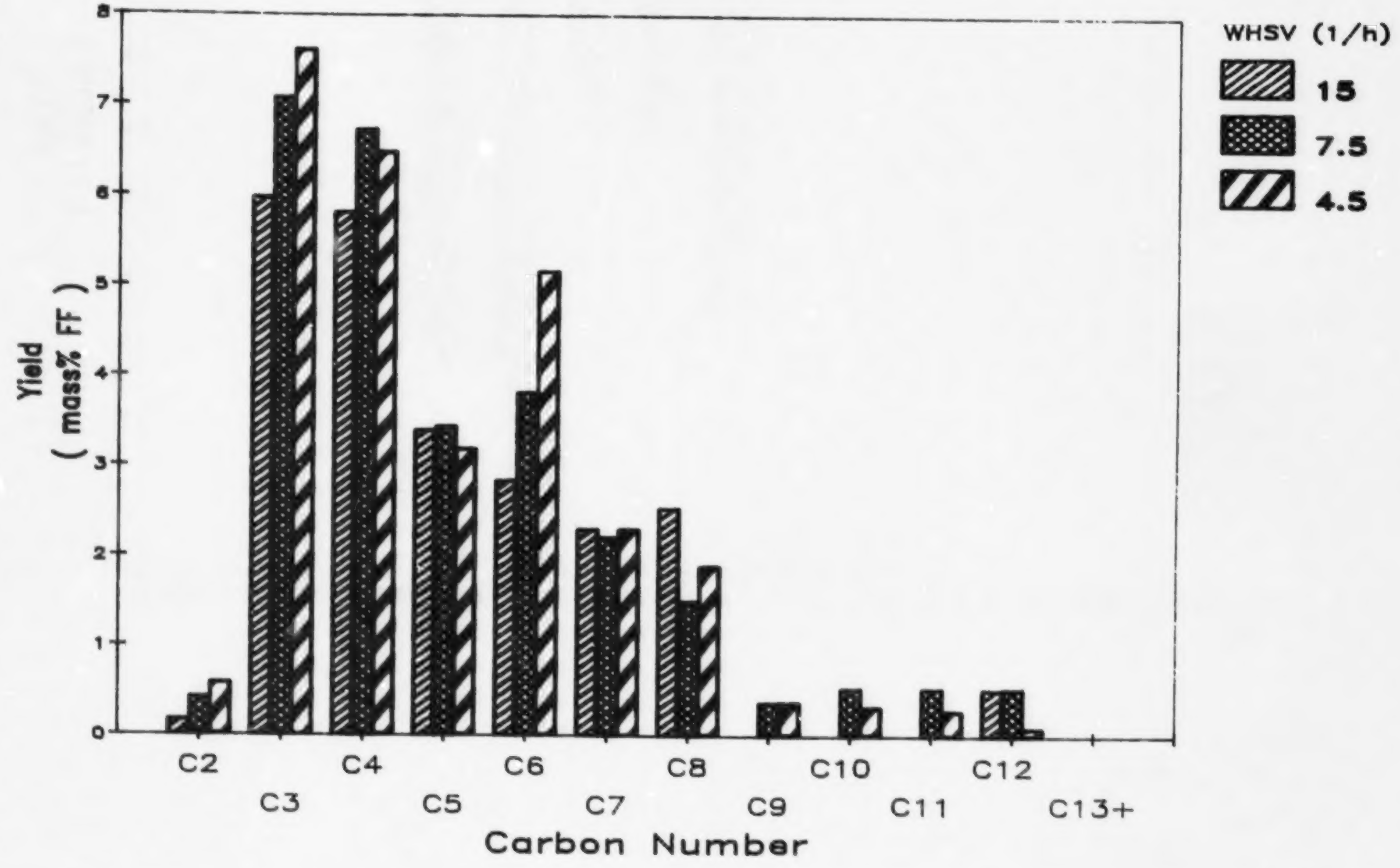
PARAFFIN DISTRIBUTION
Blend A -- 0.48% Coke



T5PA48C

Task 5. Residual Catalyst Coke on Cracking Yields

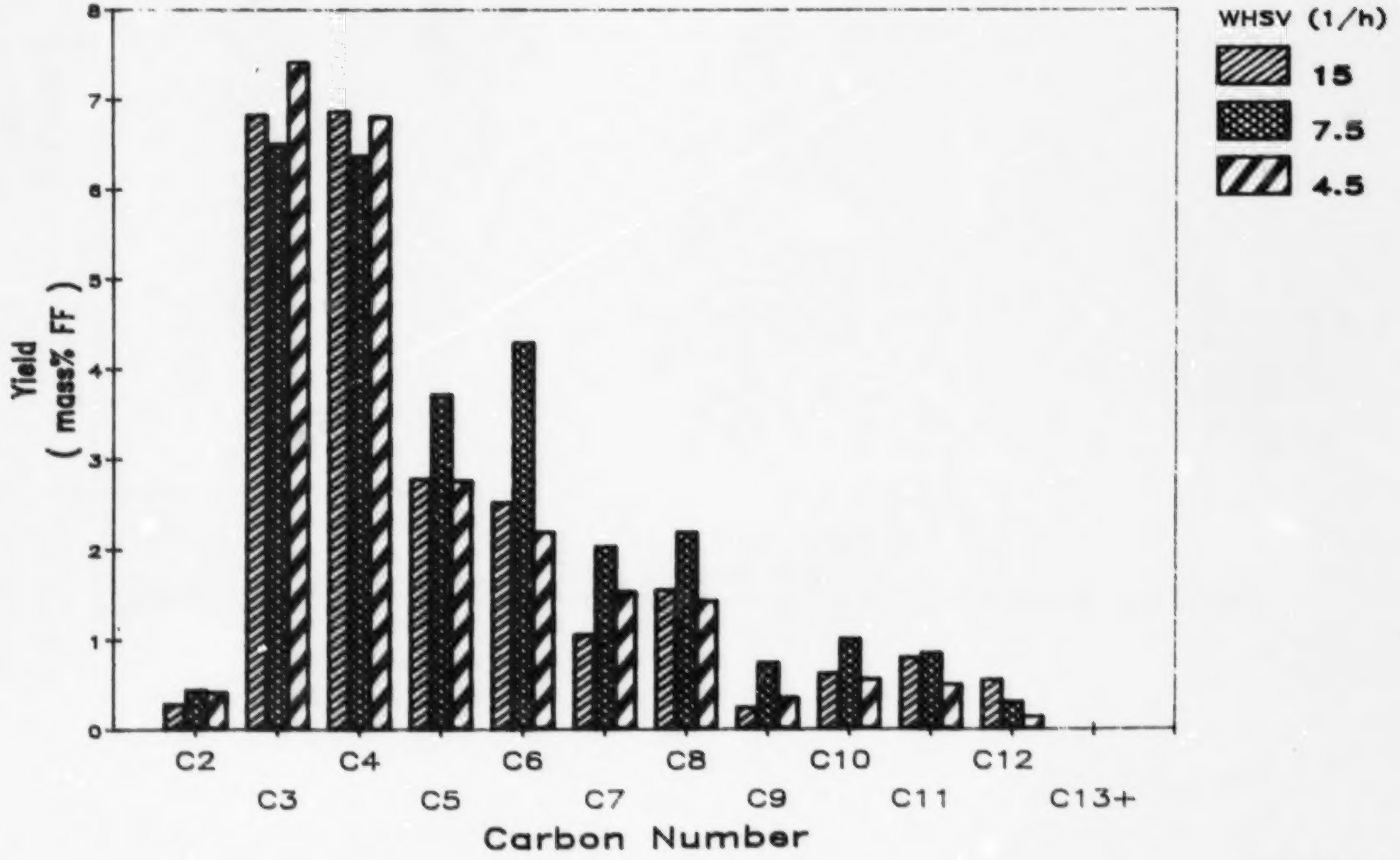
OLEFIN DISTRIBUTION
Blond A -- 0.11% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION

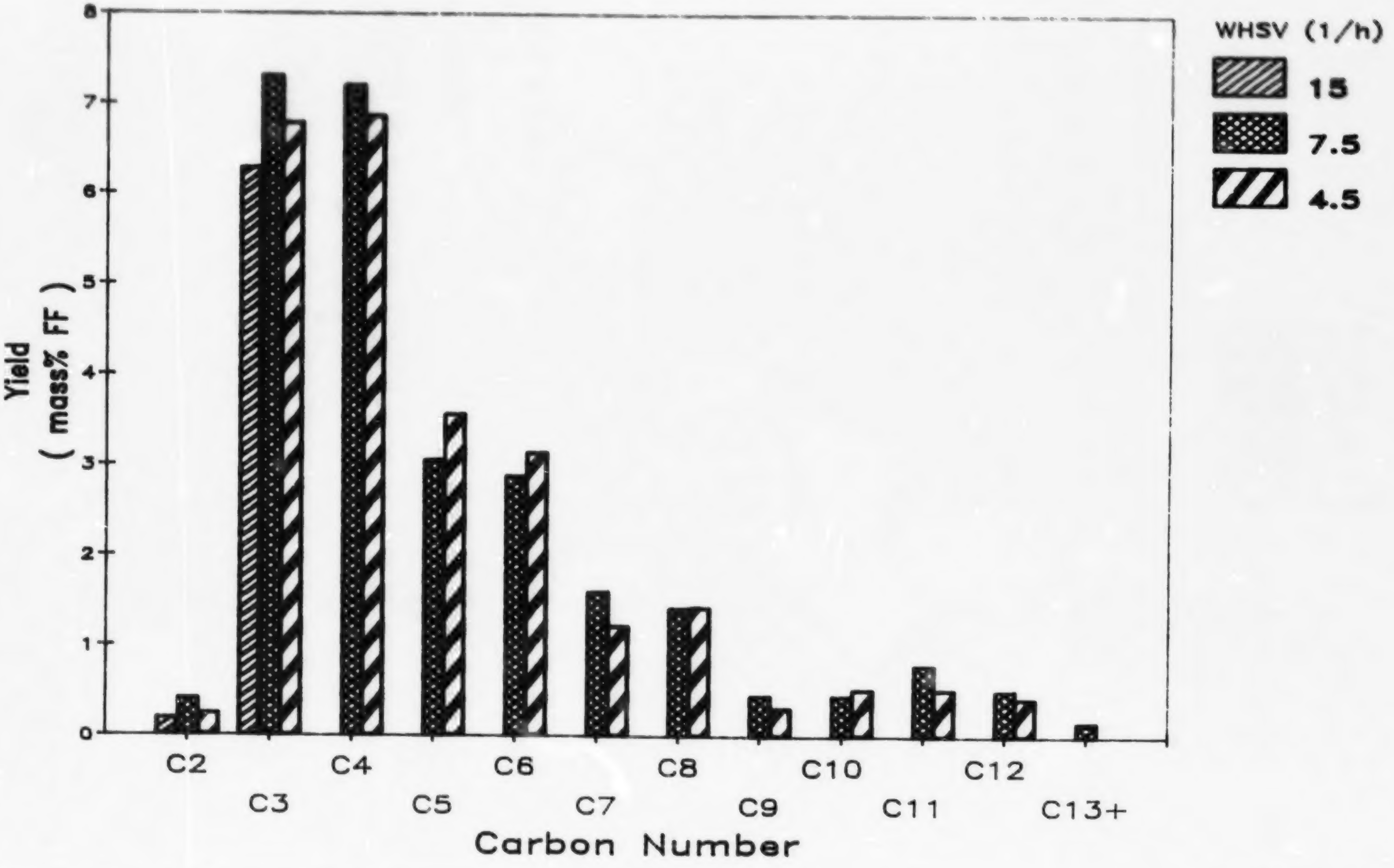
Blend A -- 0.27% Coke



T50A27C

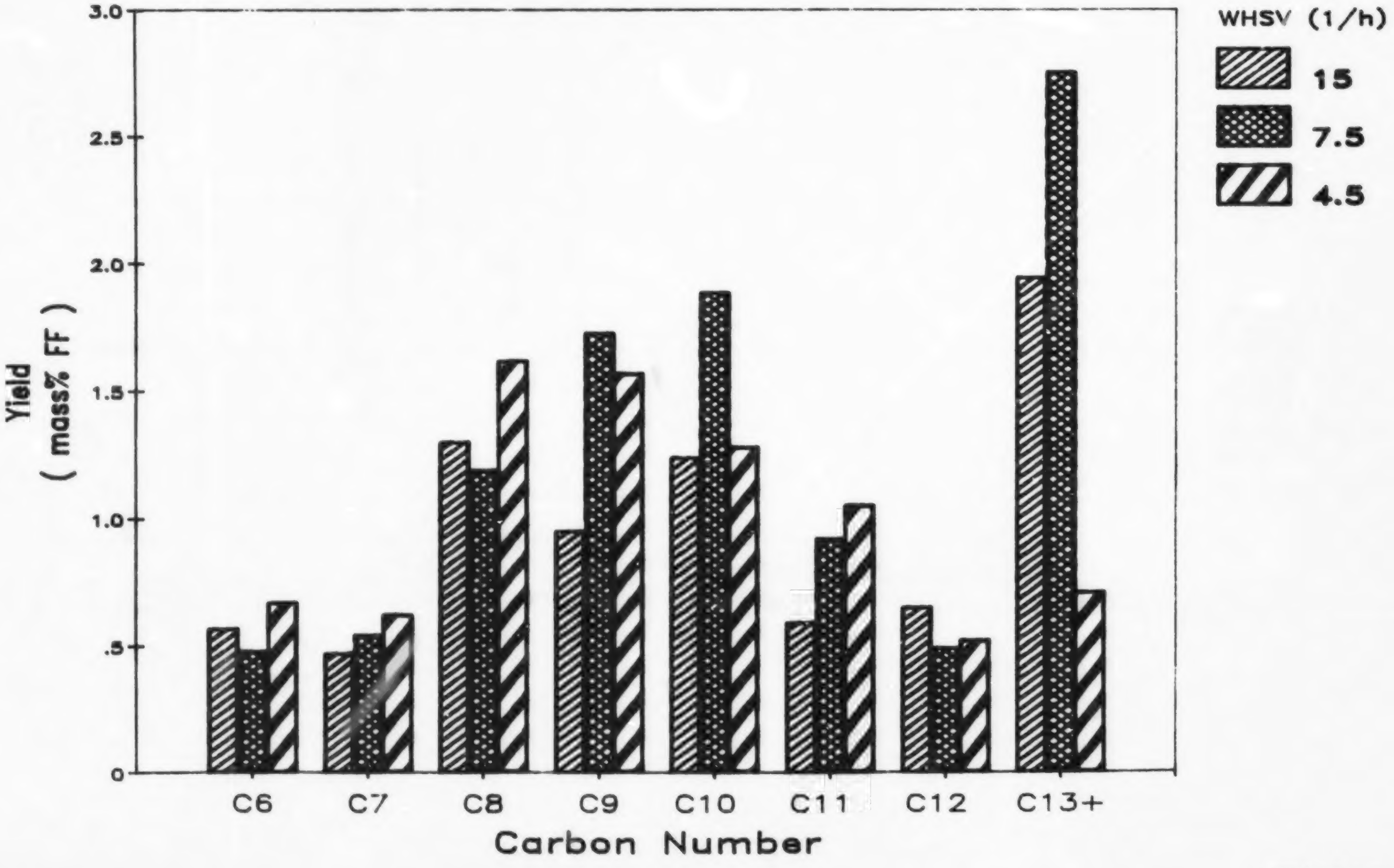
Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend A -- 0.48% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION
Blend A -- 0.11% Coke

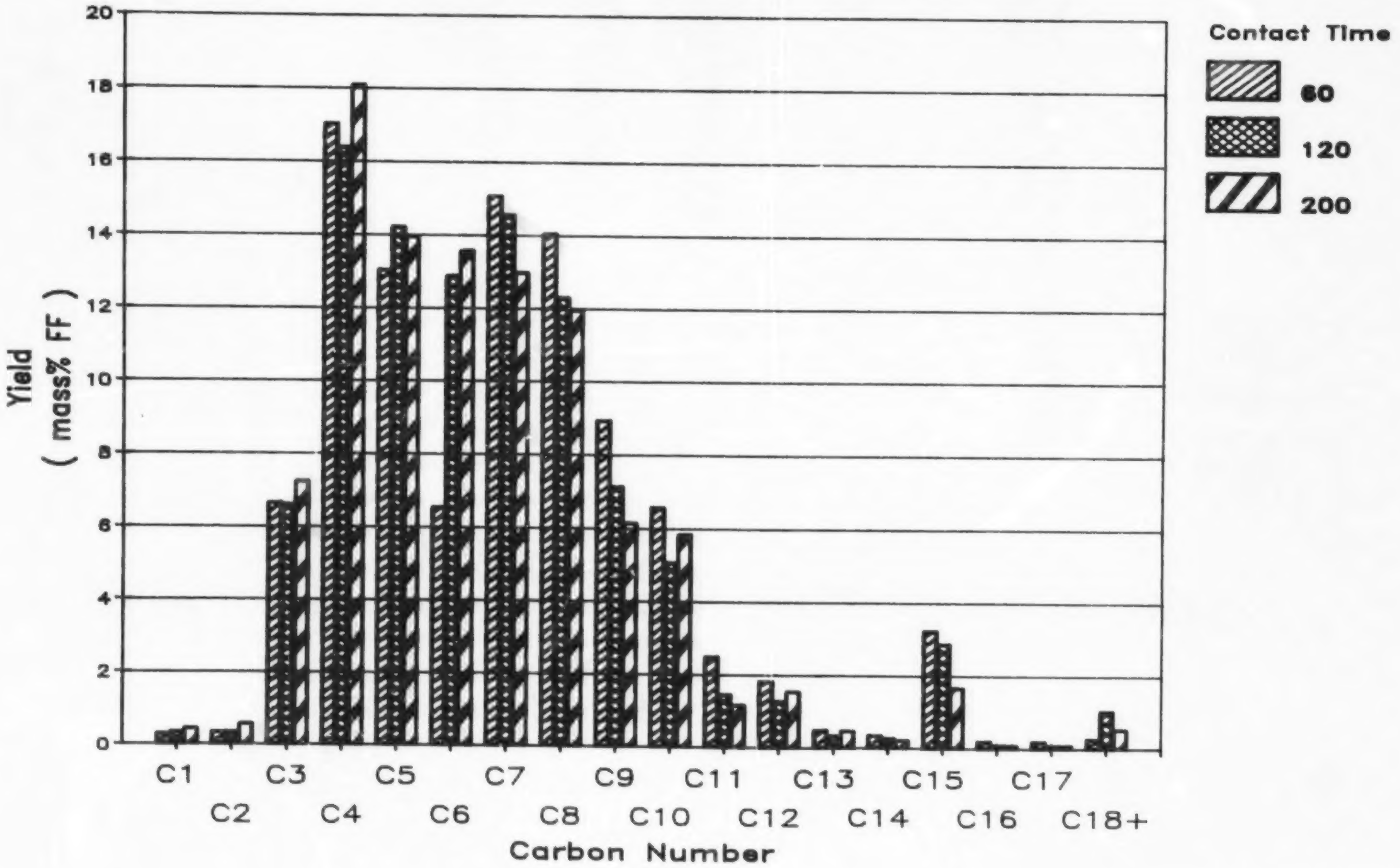


T5AA11C

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

Feed : Blend B   Catalyst : 0.11% CRC

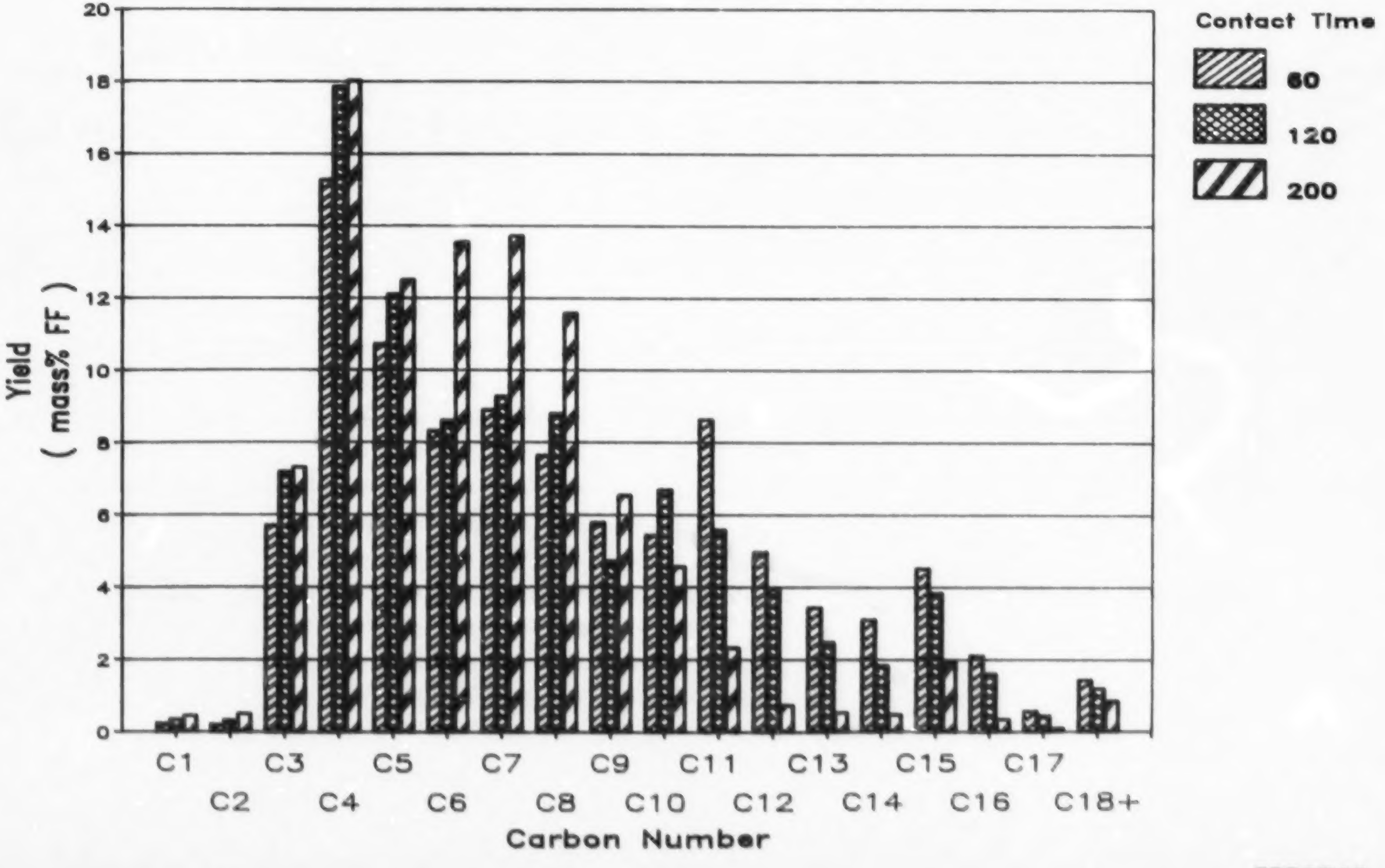


T5B11CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

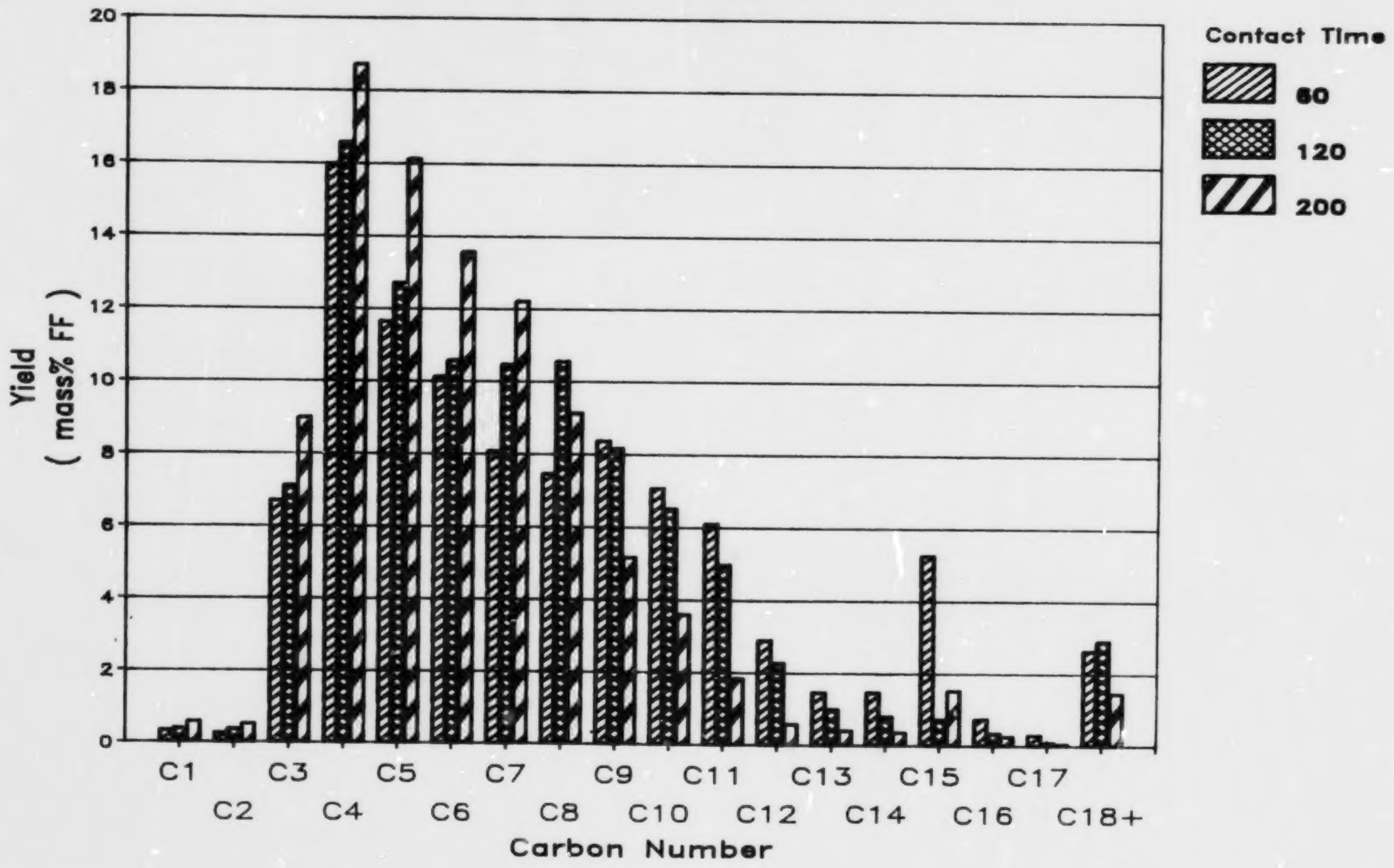
Feed : Blend B   Catalyst : 0.27% CRC



T5B27CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend B   Catalyst : 0.48% CRC

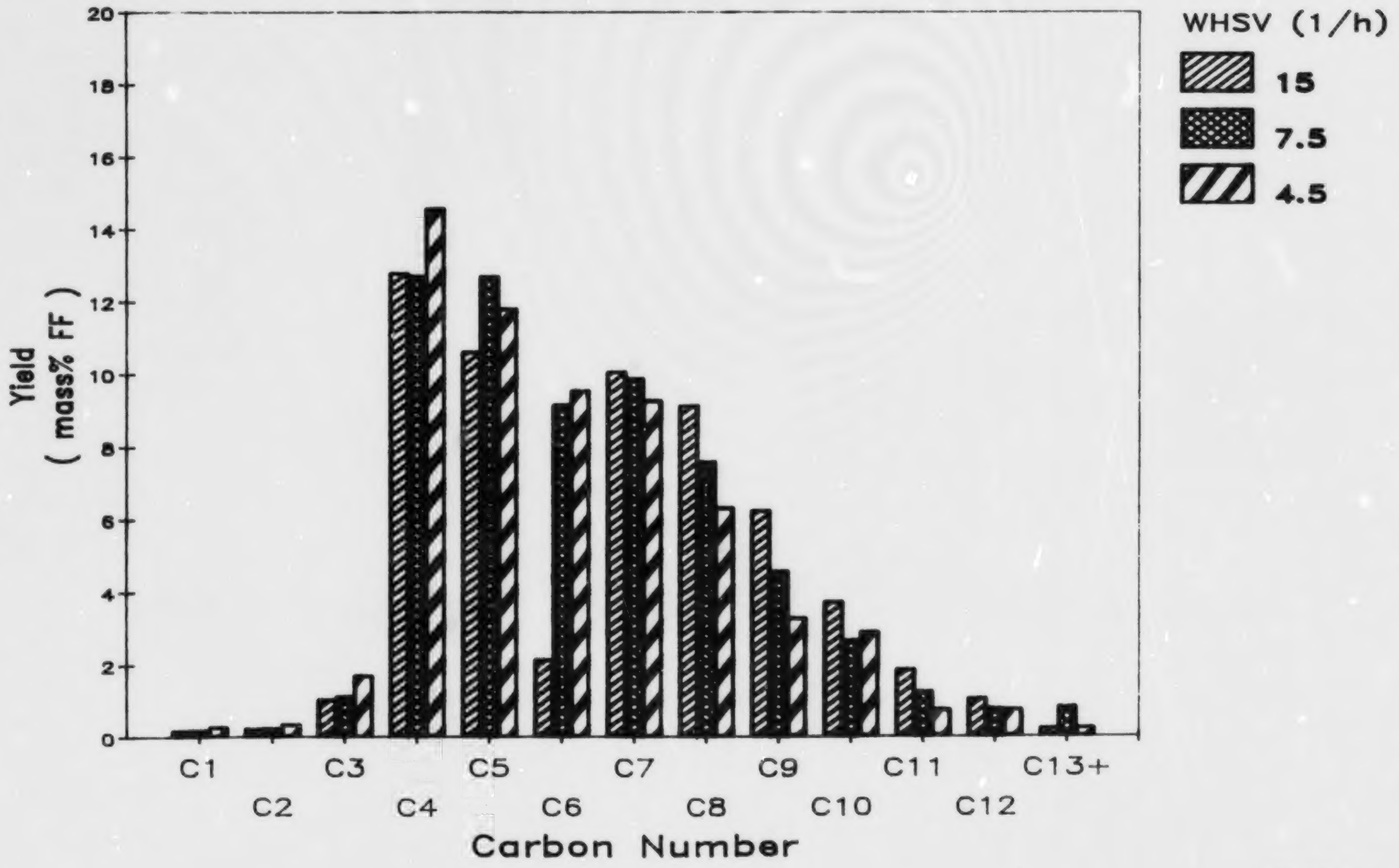


T5B48CD

Task 5. Residual Catalyst Coke on Cracking Yields

PARAFFIN DISTRIBUTION

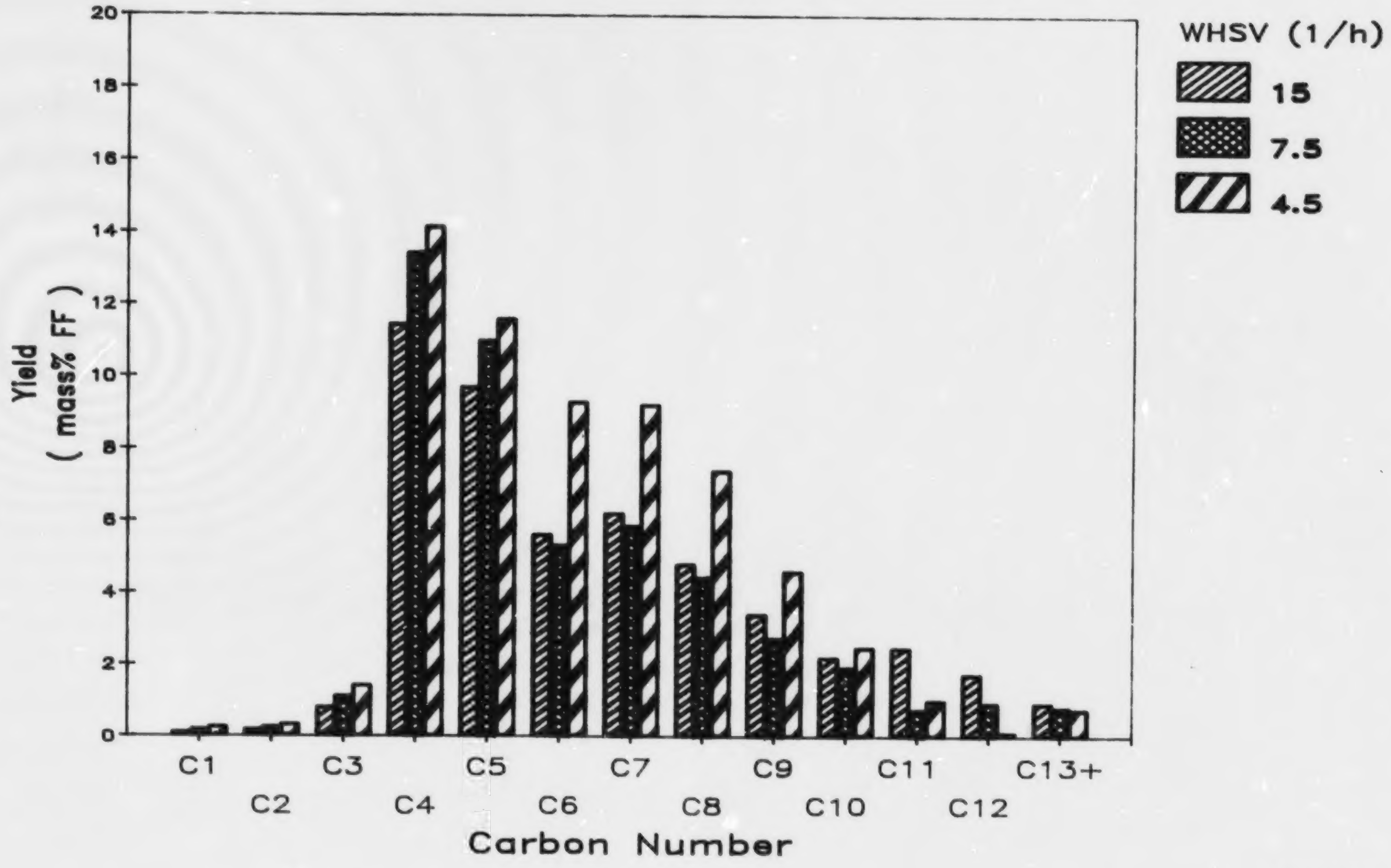
Blend B -- 0.11% Coke



T5PB11C

Task 5. Residual Catalyst Coke on Cracking Yields

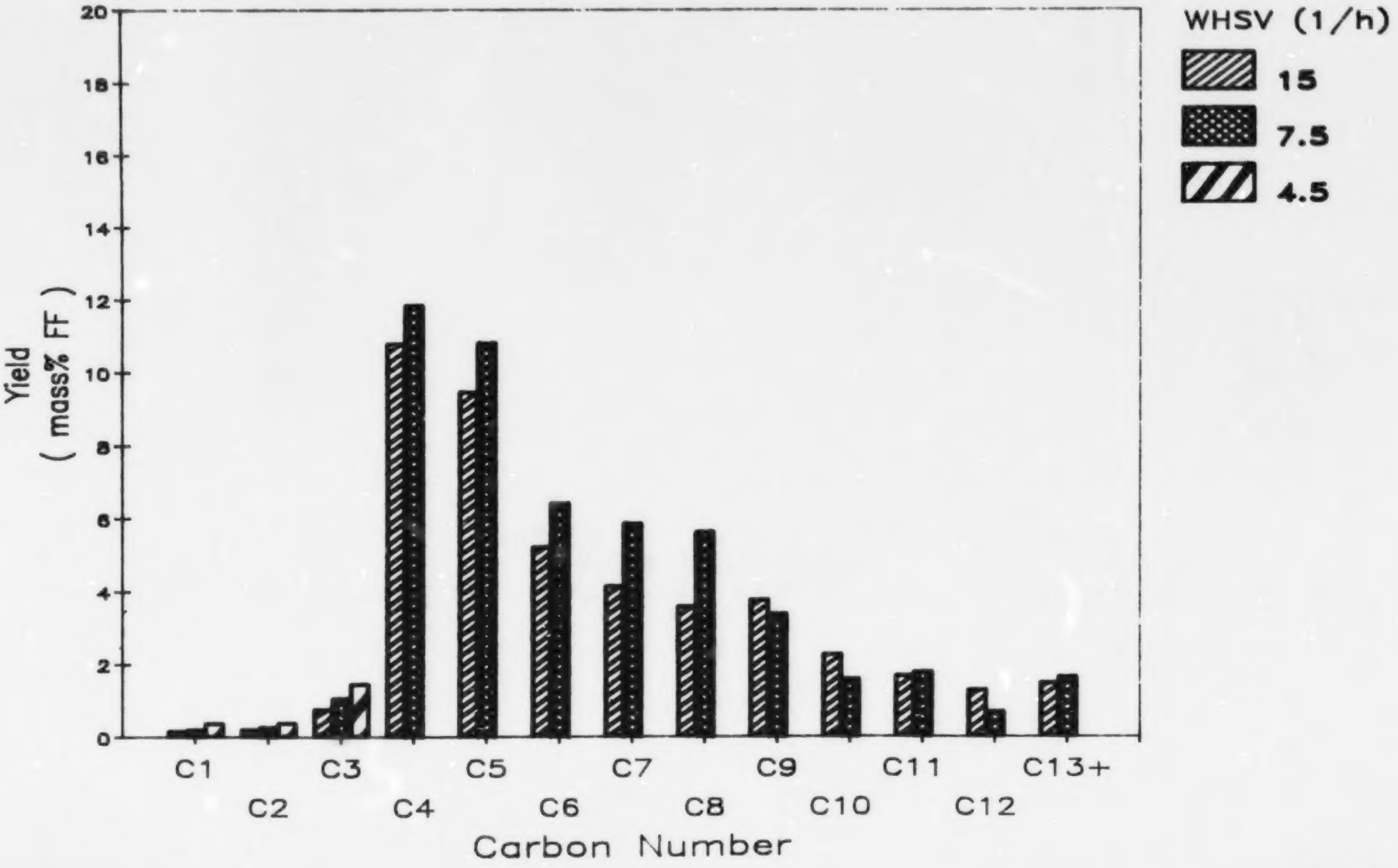
PARAFFIN DISTRIBUTION
Blend B -- 0.27% Coke



T5PB27C

Task 5. Residual Catalyst Coke on Cracking Yields

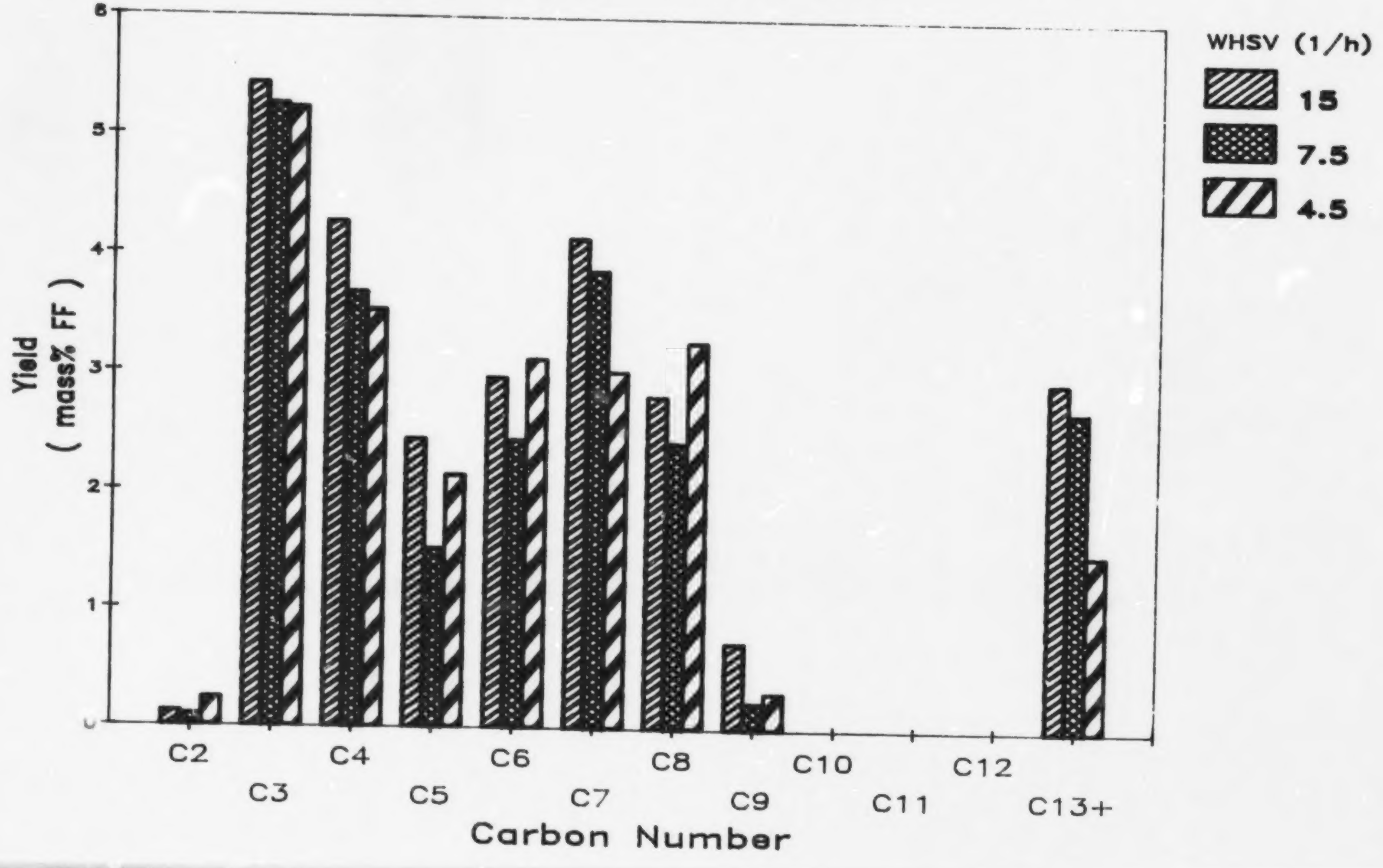
PARAFFIN DISTRIBUTION
Blend B -- 0.48% Coke



T5PB48C

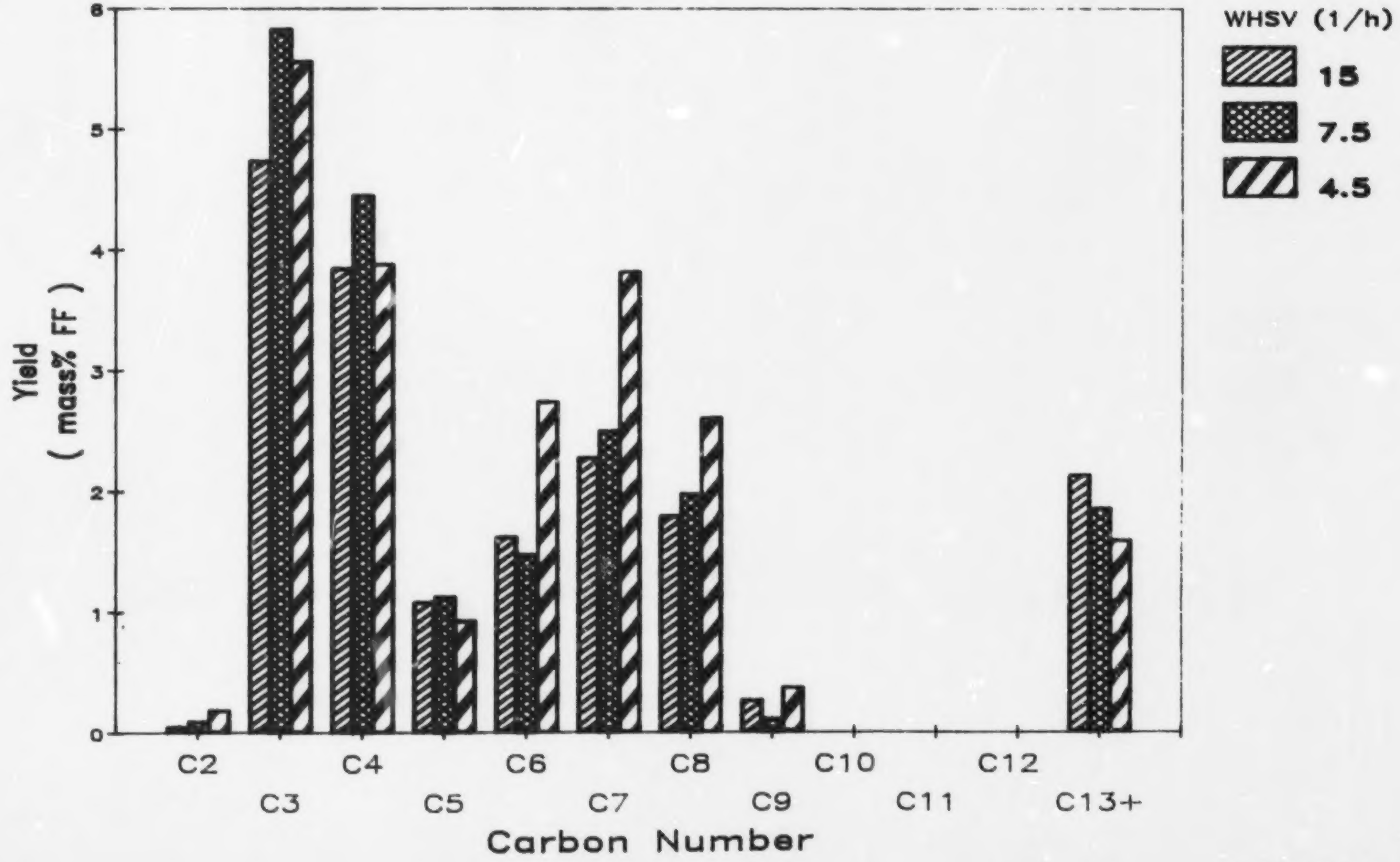
Task 5. Residual Catalyst Coke on Cracking Yields

OLDFIN DISTRIBUTION
Blend B -- 0.11% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

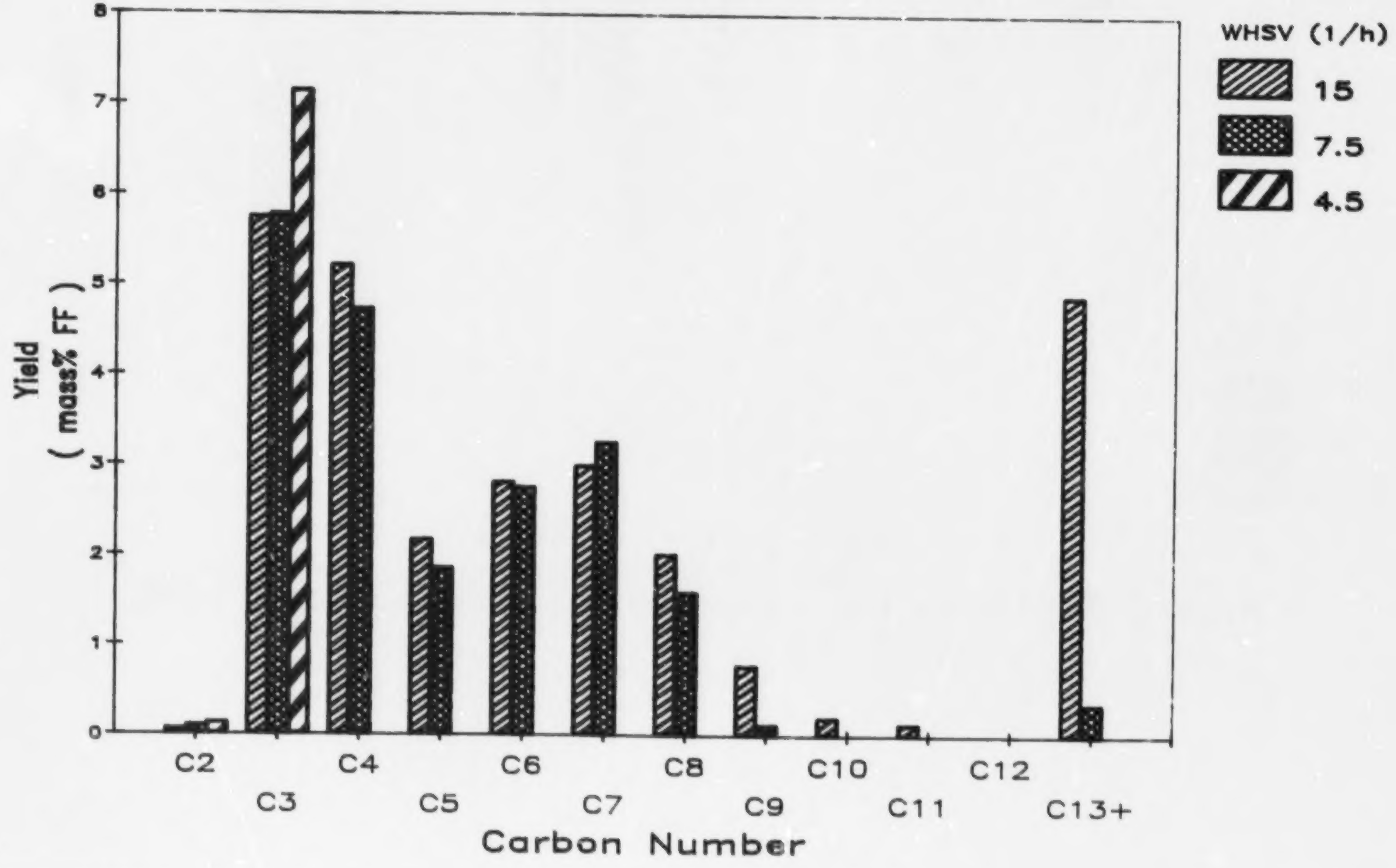
OLDFIN DISTRIBUTION
Blend B -- 0.27% Coke



T50B27C

Task 5. Residual Catalyst Coke on Cracking Yields

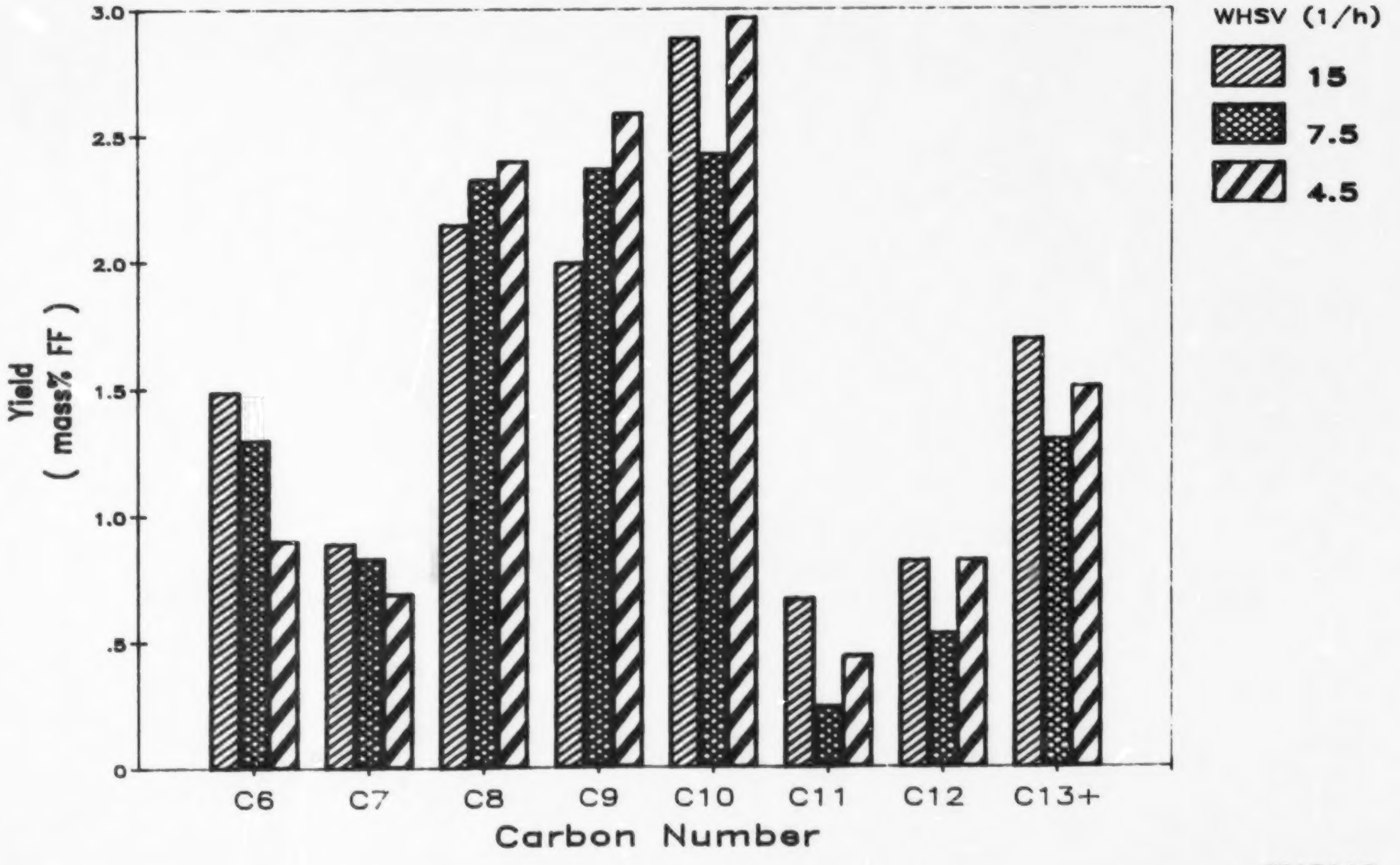
OLEFIN DISTRIBUTION
Blend B -- 0.48% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend B   Catalyst : 0.11% CRC

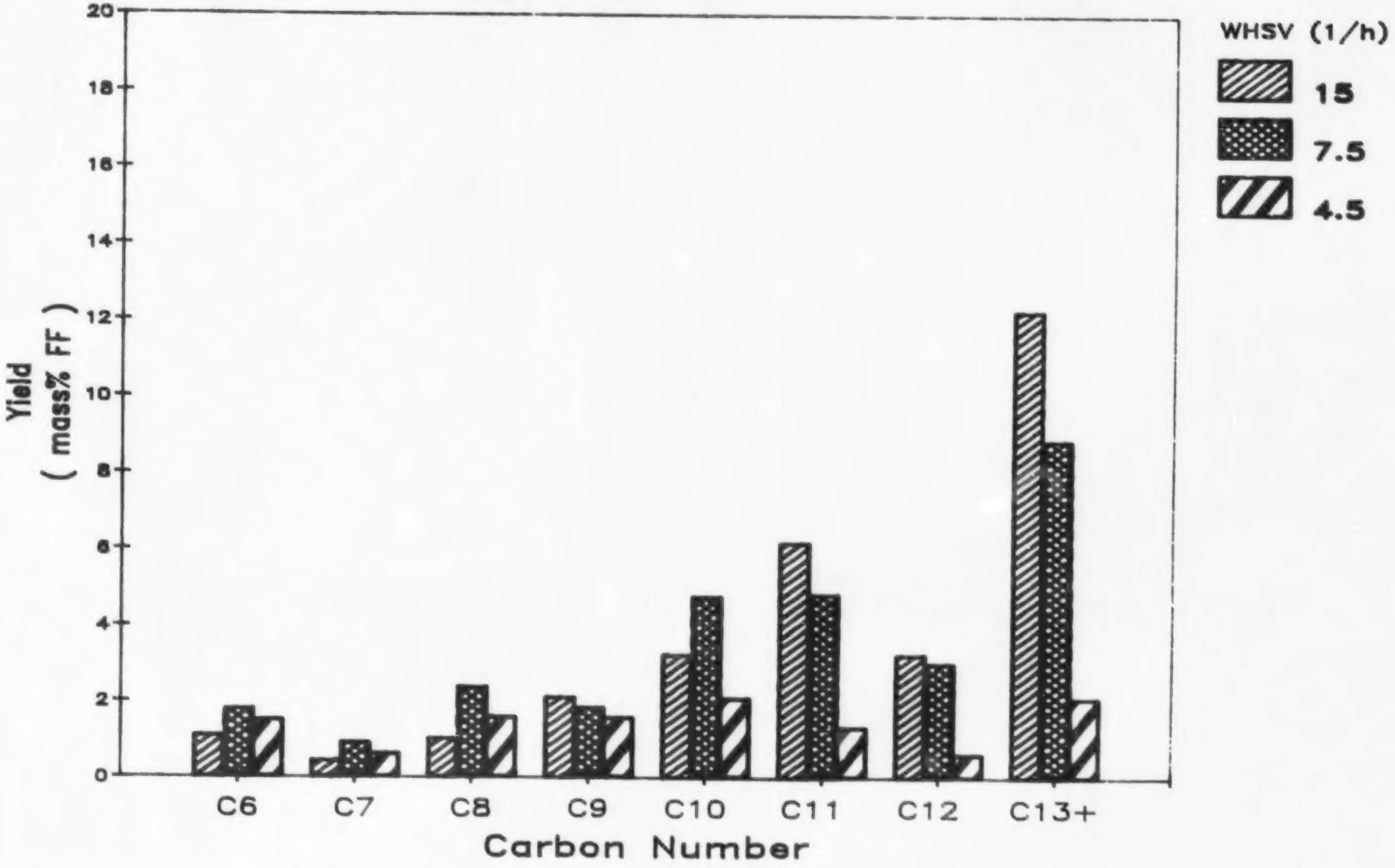


T5AB11C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

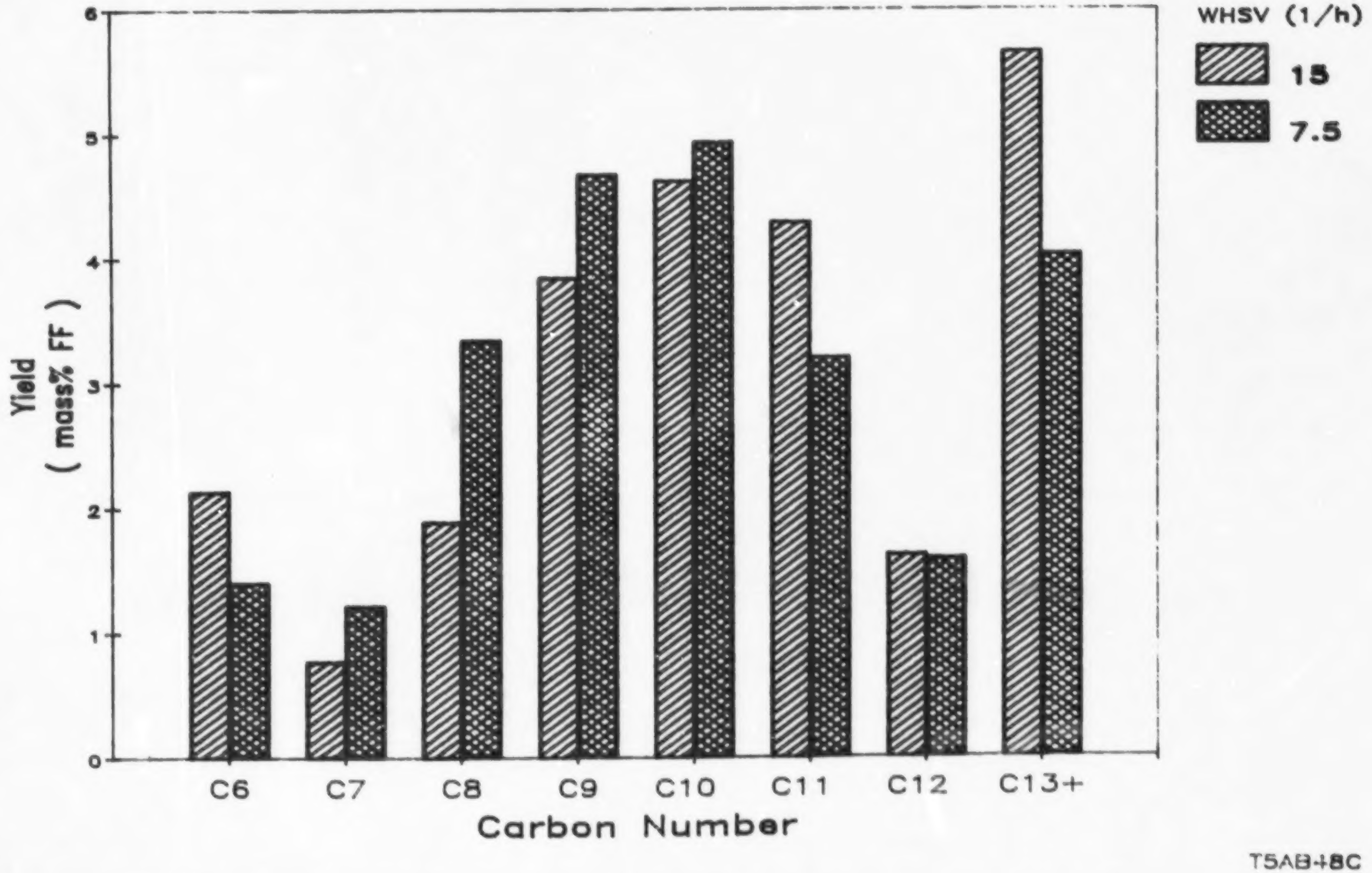
Feed : Blend B   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend B Catalyst : 0.48% CRC

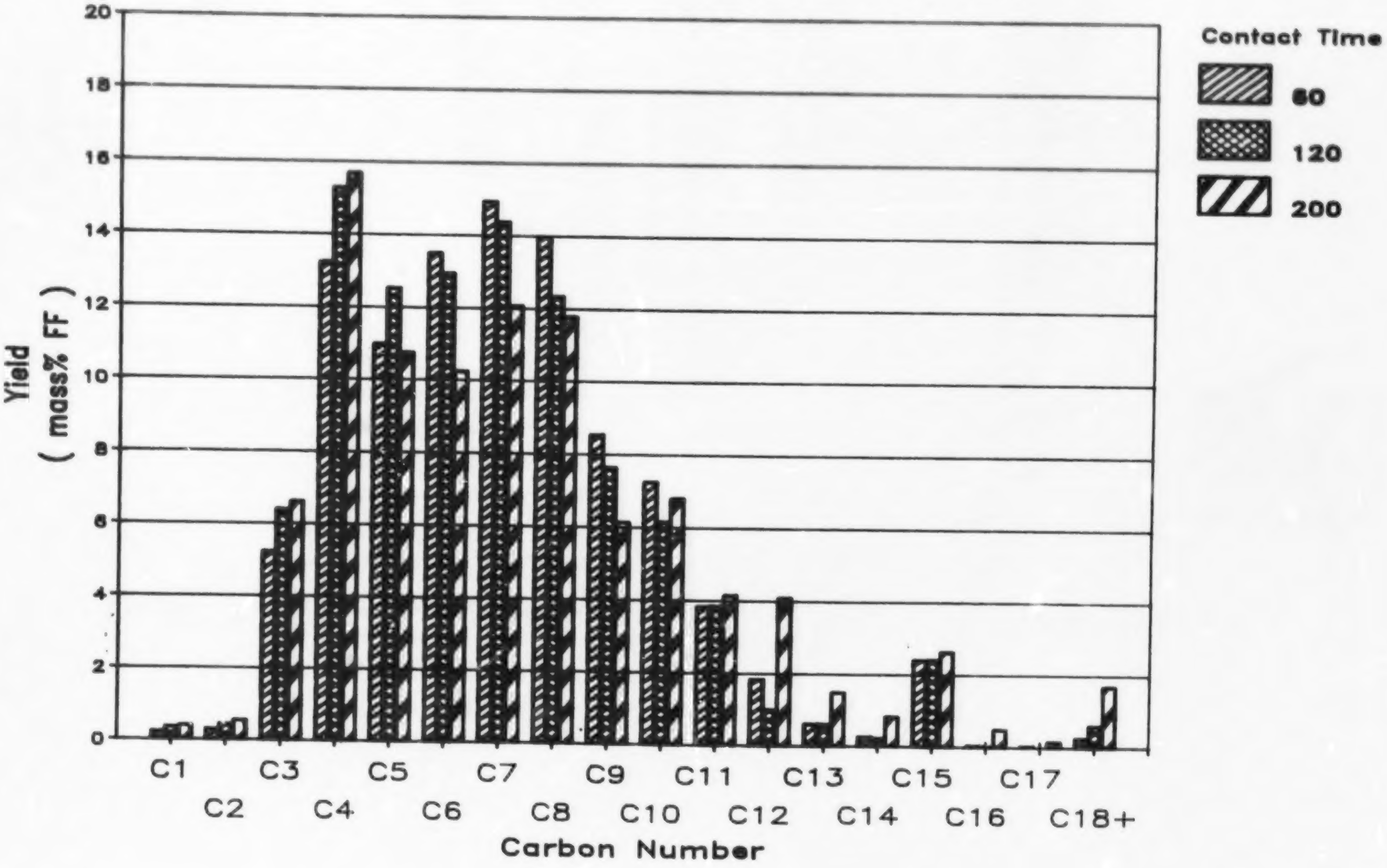


T5AB+8C

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

Feed : Blend C   Catalyst : 0.11% CRC

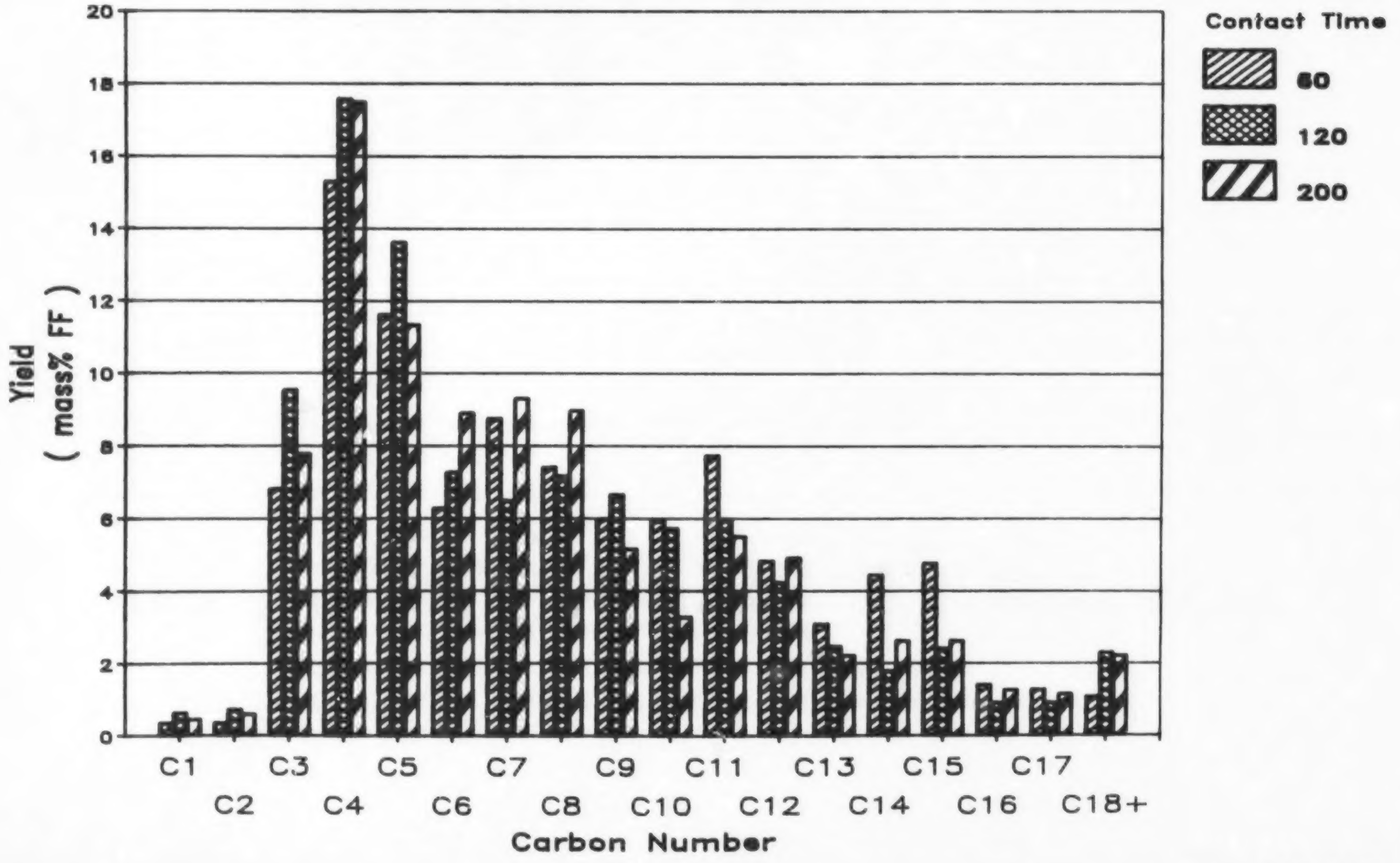


T5C11CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

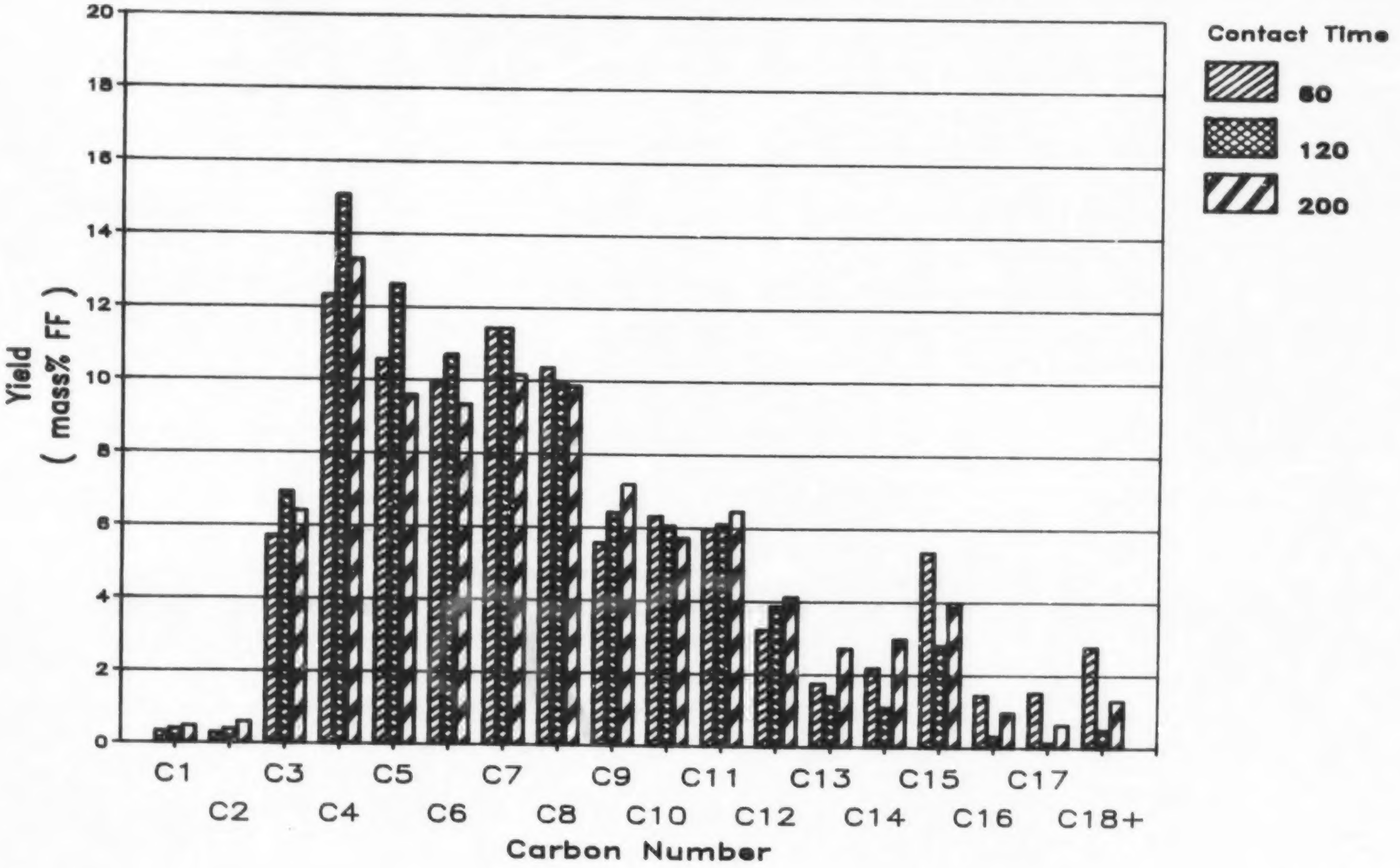
Feed : Blend C   Catalyst : 0.27% CRC



T5C27CD

Task 5. Residual Catalyst Coke on Cracking Yields

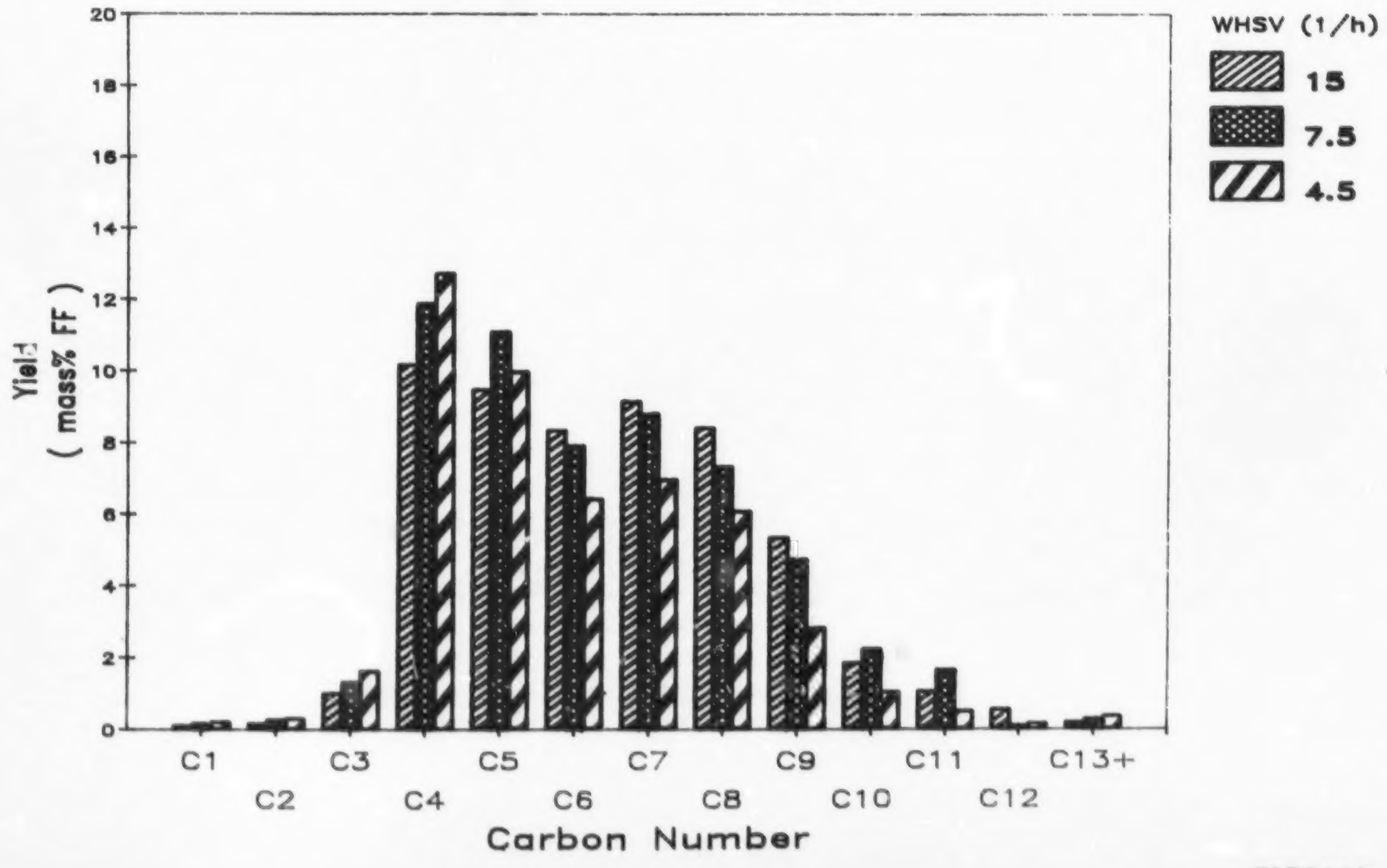
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend C   Catalyst : 0.48% CRC



T5C48CD

Task 5. Residual Catalyst Coke on Cracking Yields

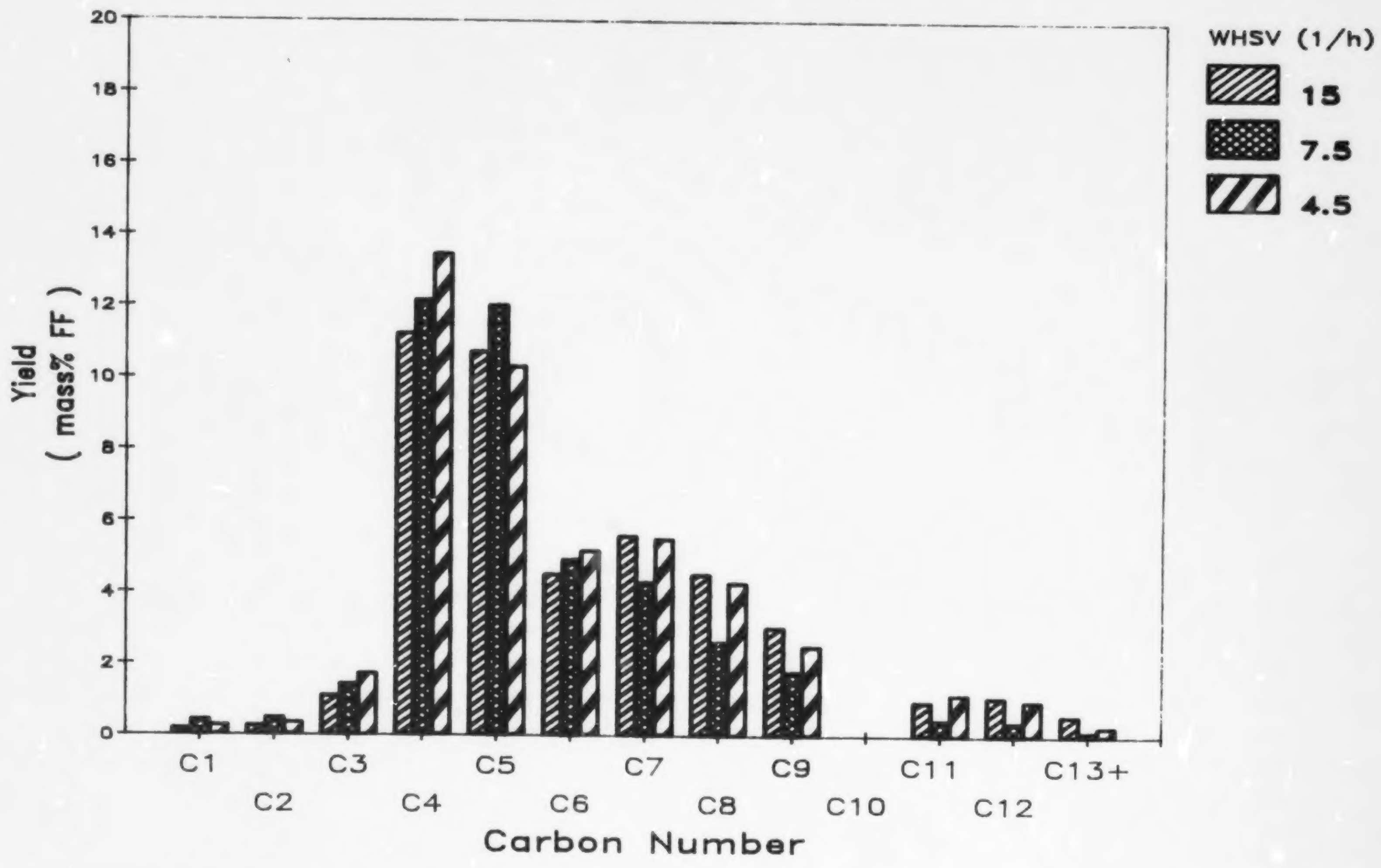
PARAFFIN DISTRIBUTION
Blend C -- 0.11% Coke



T5PC11C

Task 5. Residual Catalyst Coke on Cracking Yields

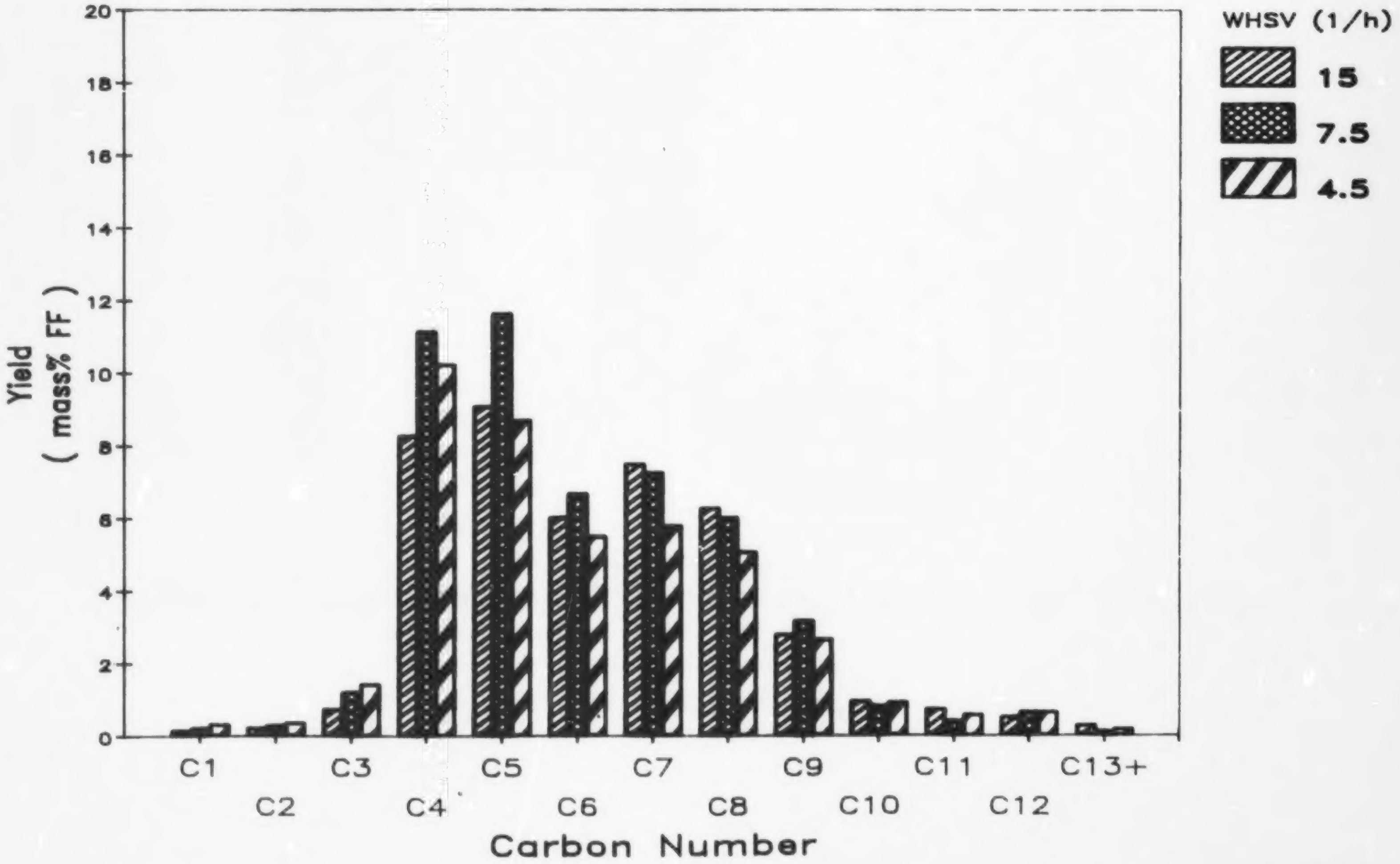
PARAFFIN DISTRIBUTION
Blend C -- 0.27% Coke



T5PC27C

Task 5. Residual Catalyst Coke on Cracking Yields

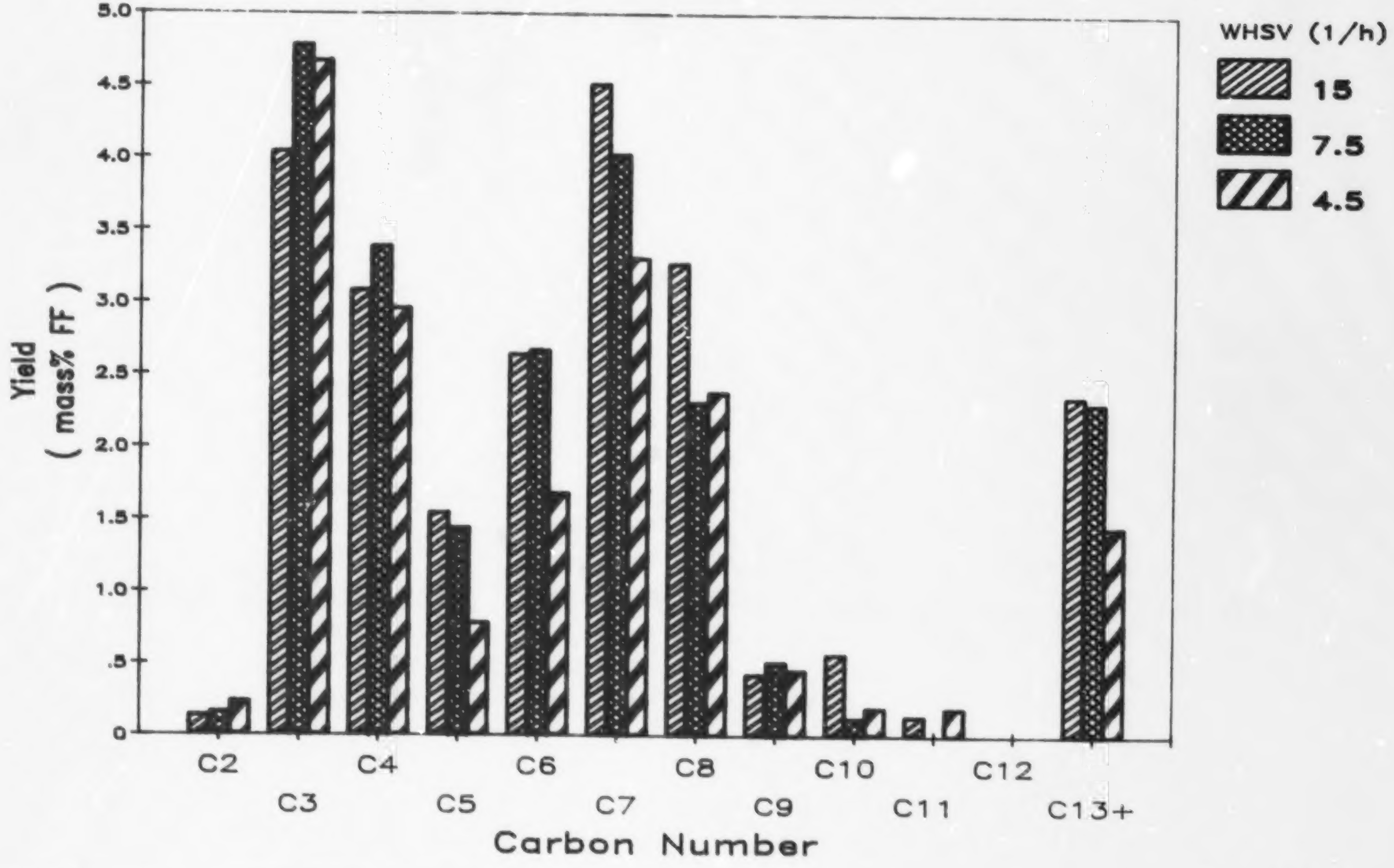
PARAFFIN DISTRIBUTION
Blend C -- 0.48% Coke



T5PC48C

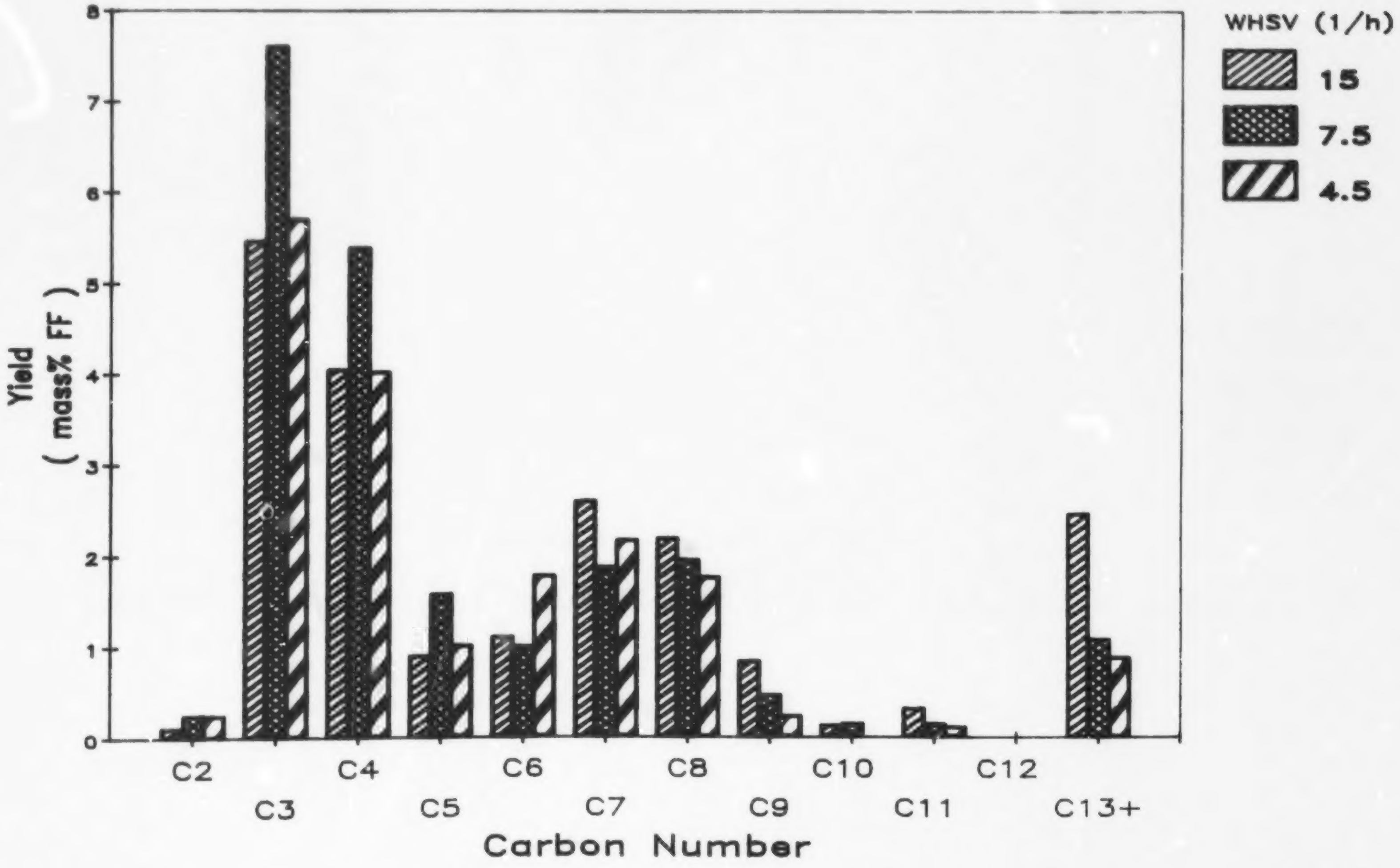
Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend C -- 0.11% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

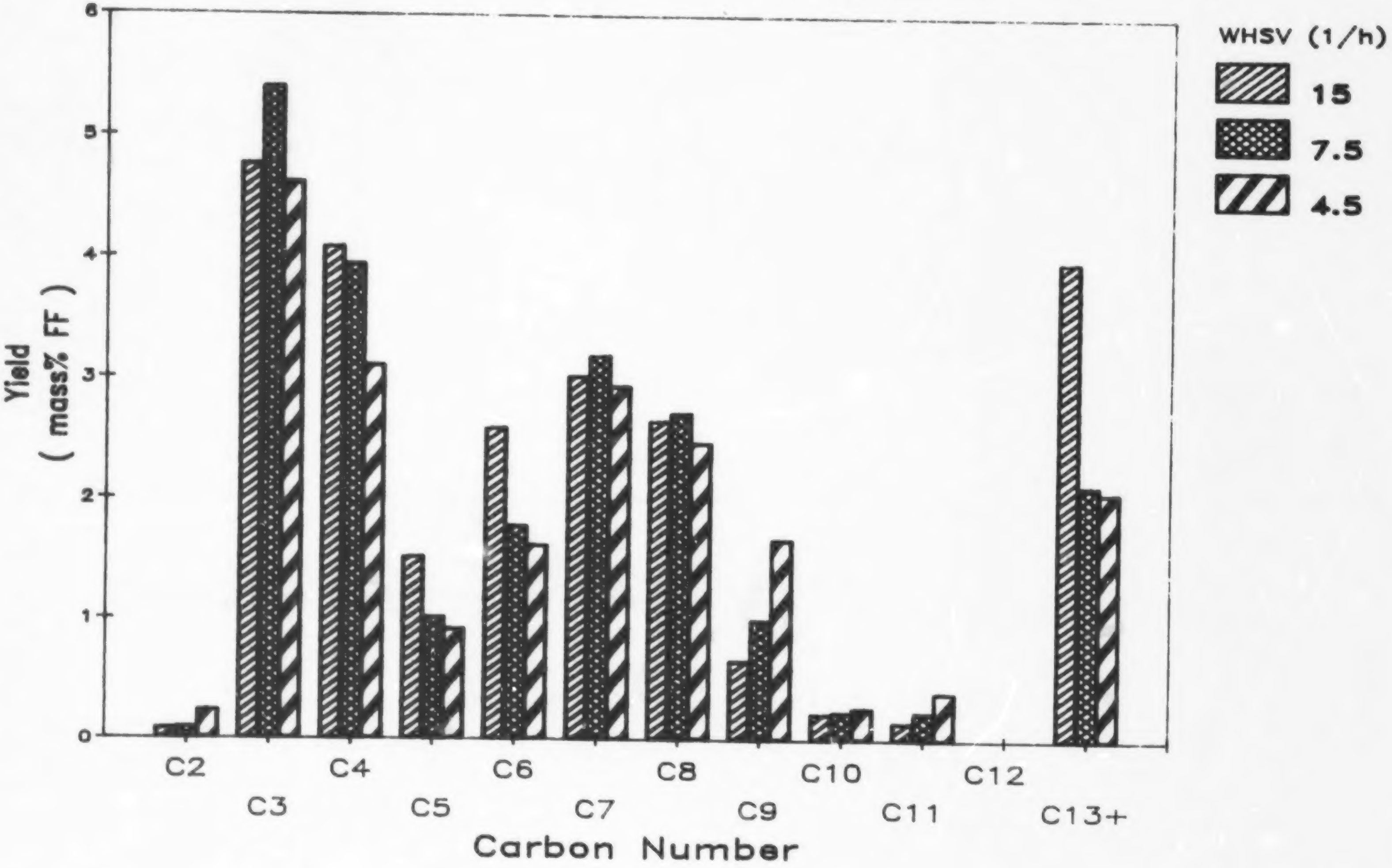
OLEFIN DISTRIBUTION
Blend C -- 0.27% Coke



T5OC27C

Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend C -- 0.48% Coke

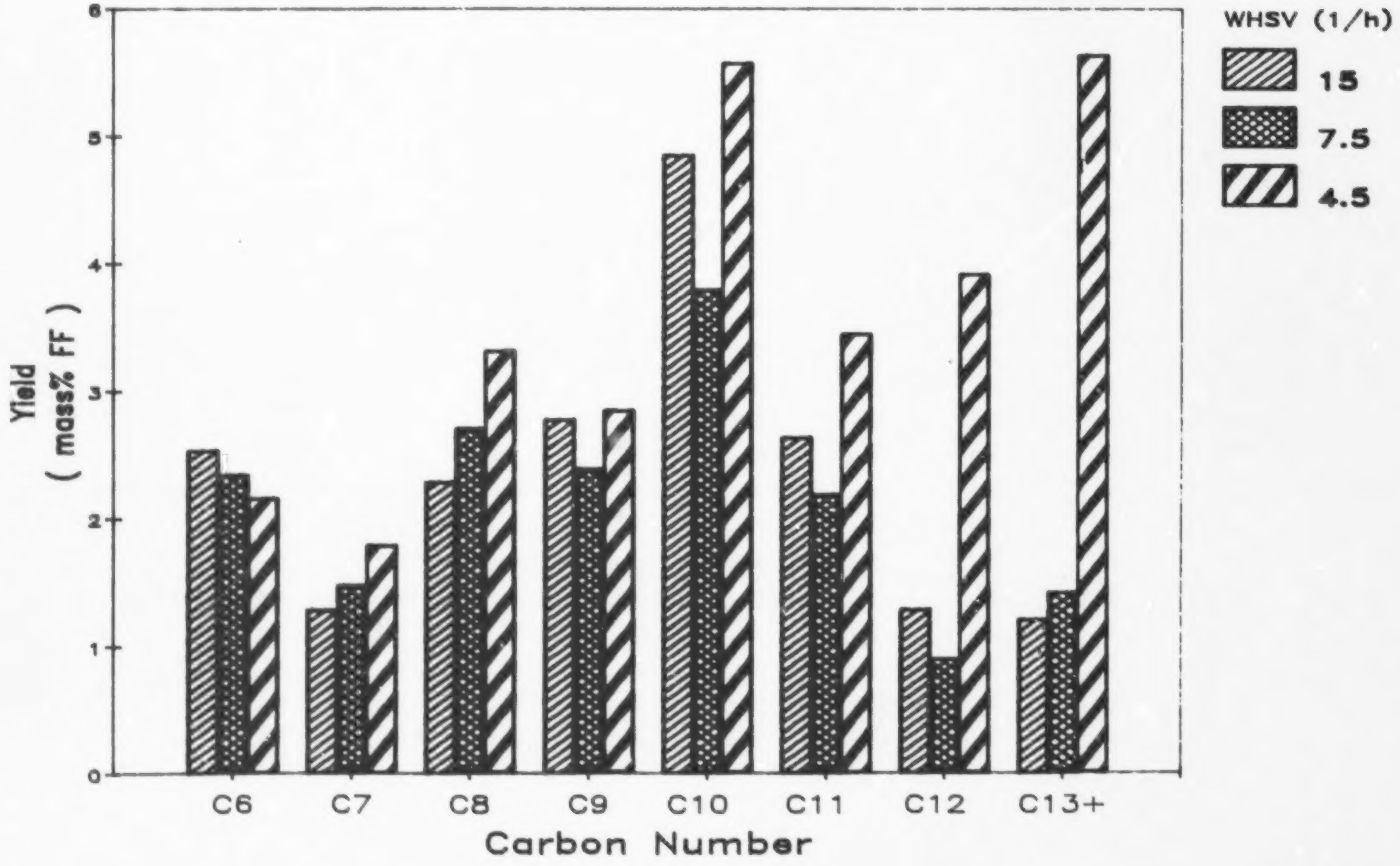


T5OC48C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend C Catalyst : 0.11% CRC

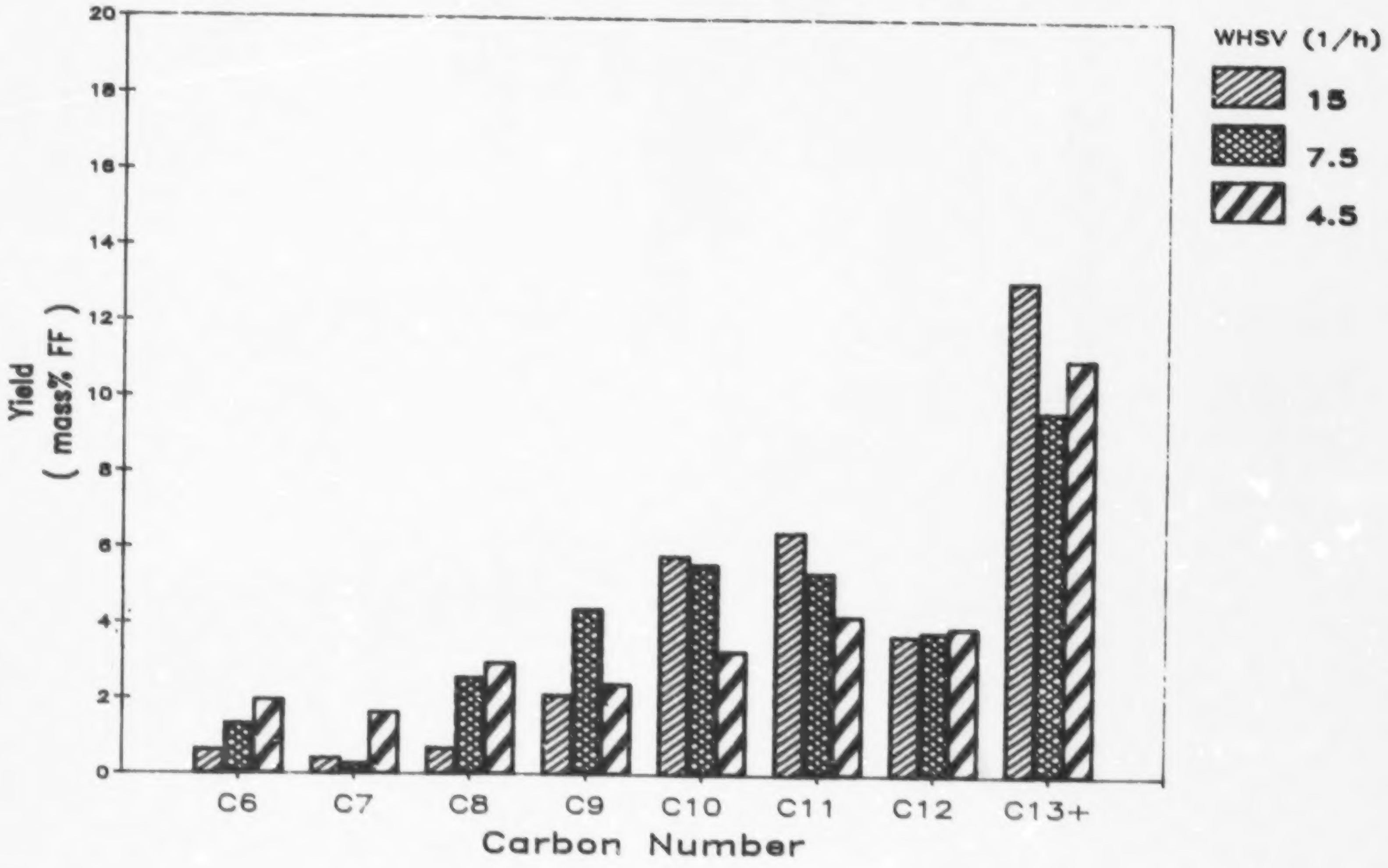


T5AC11C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

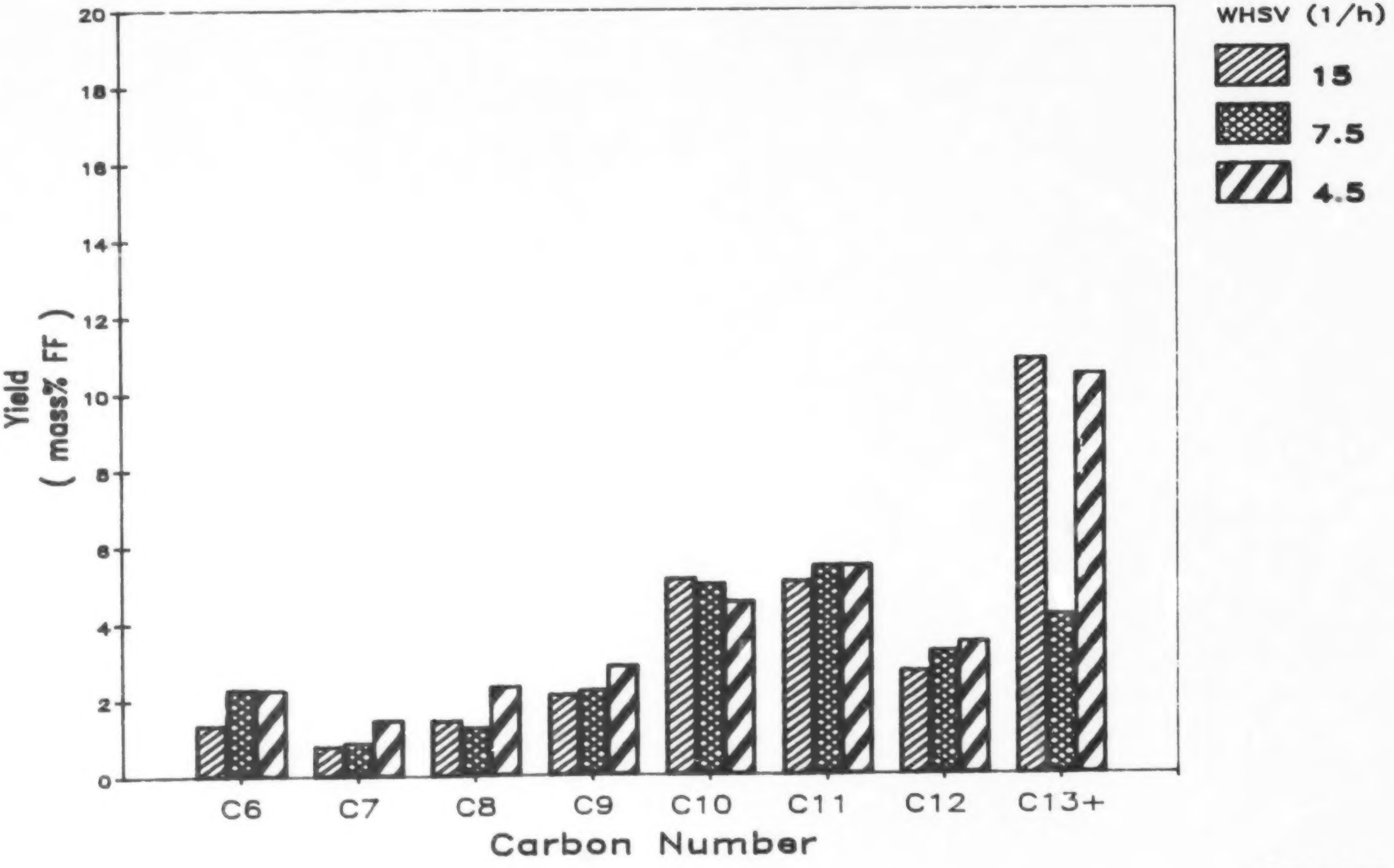
Feed : Blend C   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend C   Catalyst : 0.48% CRC

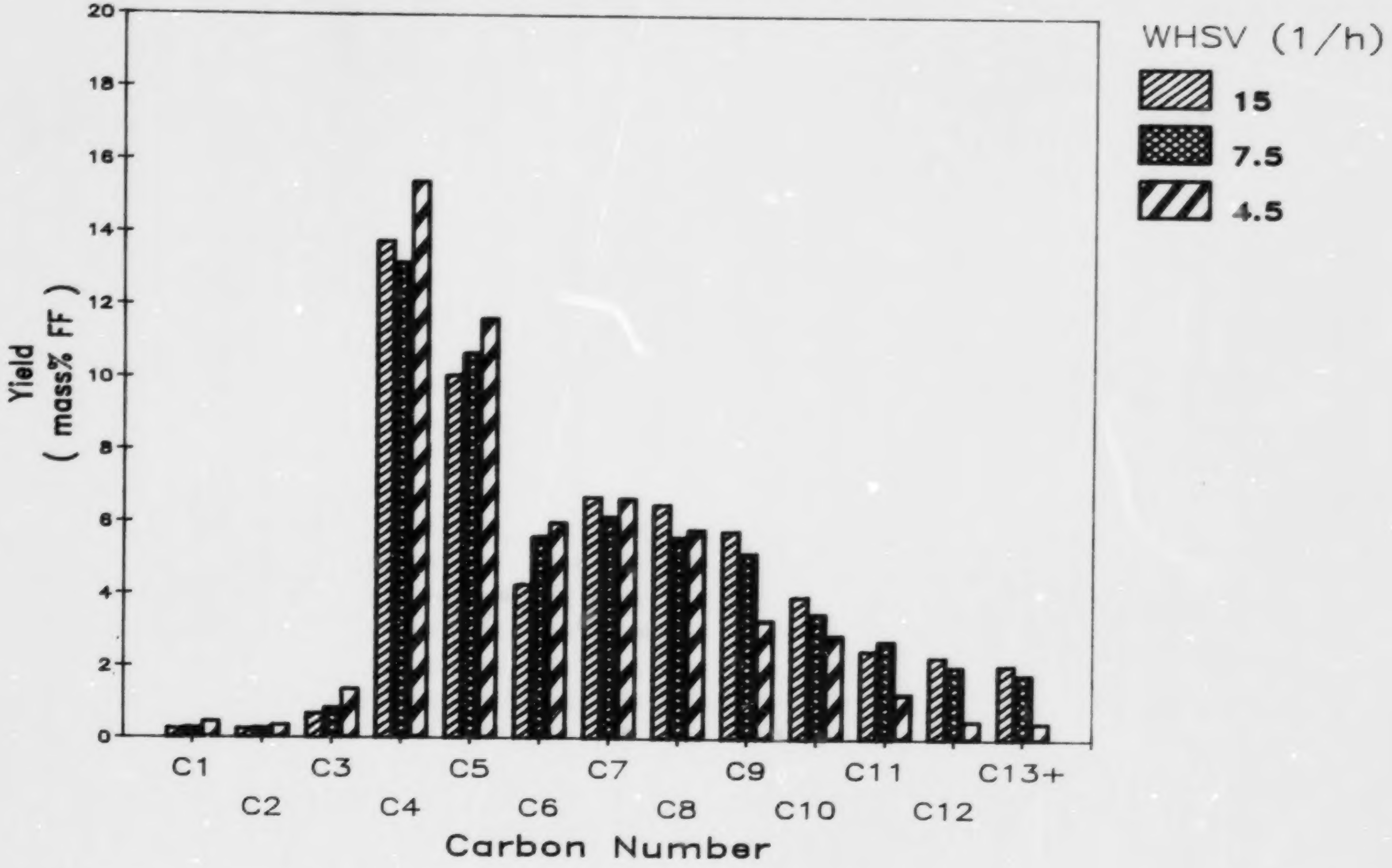


T5AC48C

Task 2. Cradking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION

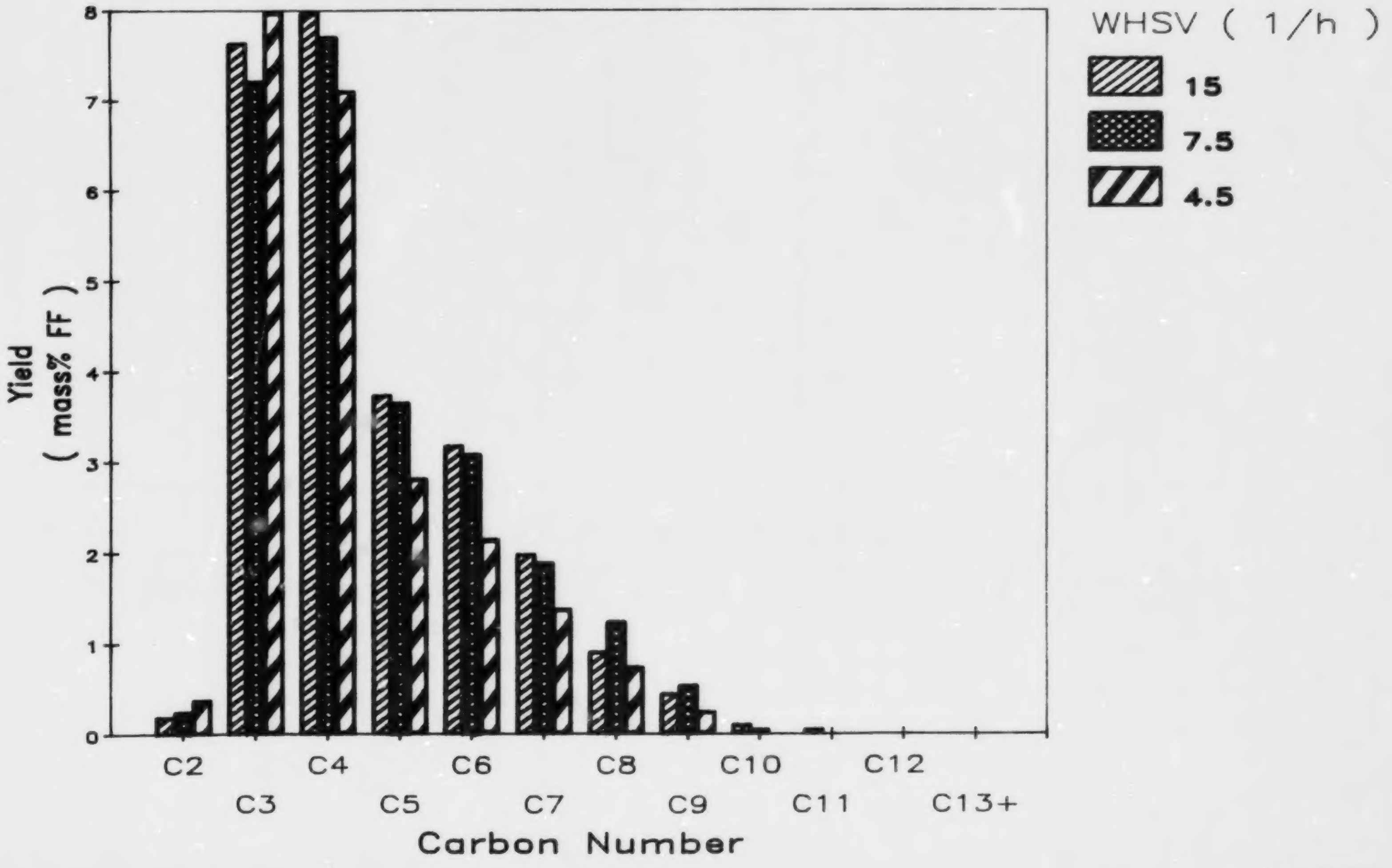
2,4,6,10-Tetramethylpentadecane



Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION

2,4,6,10-Tetramethylpentadecane

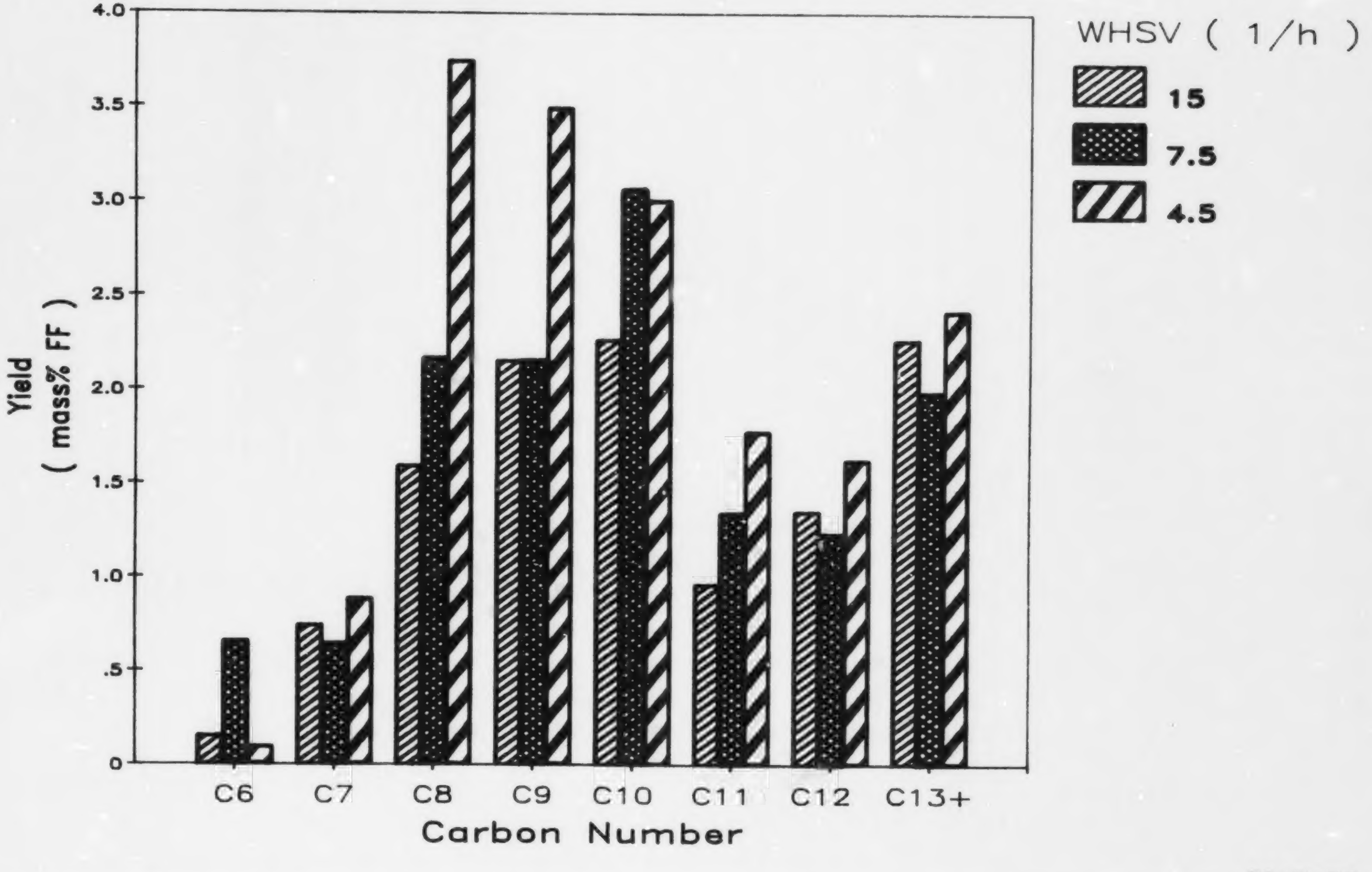


T2OTMPD

Task 2. Cradking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION

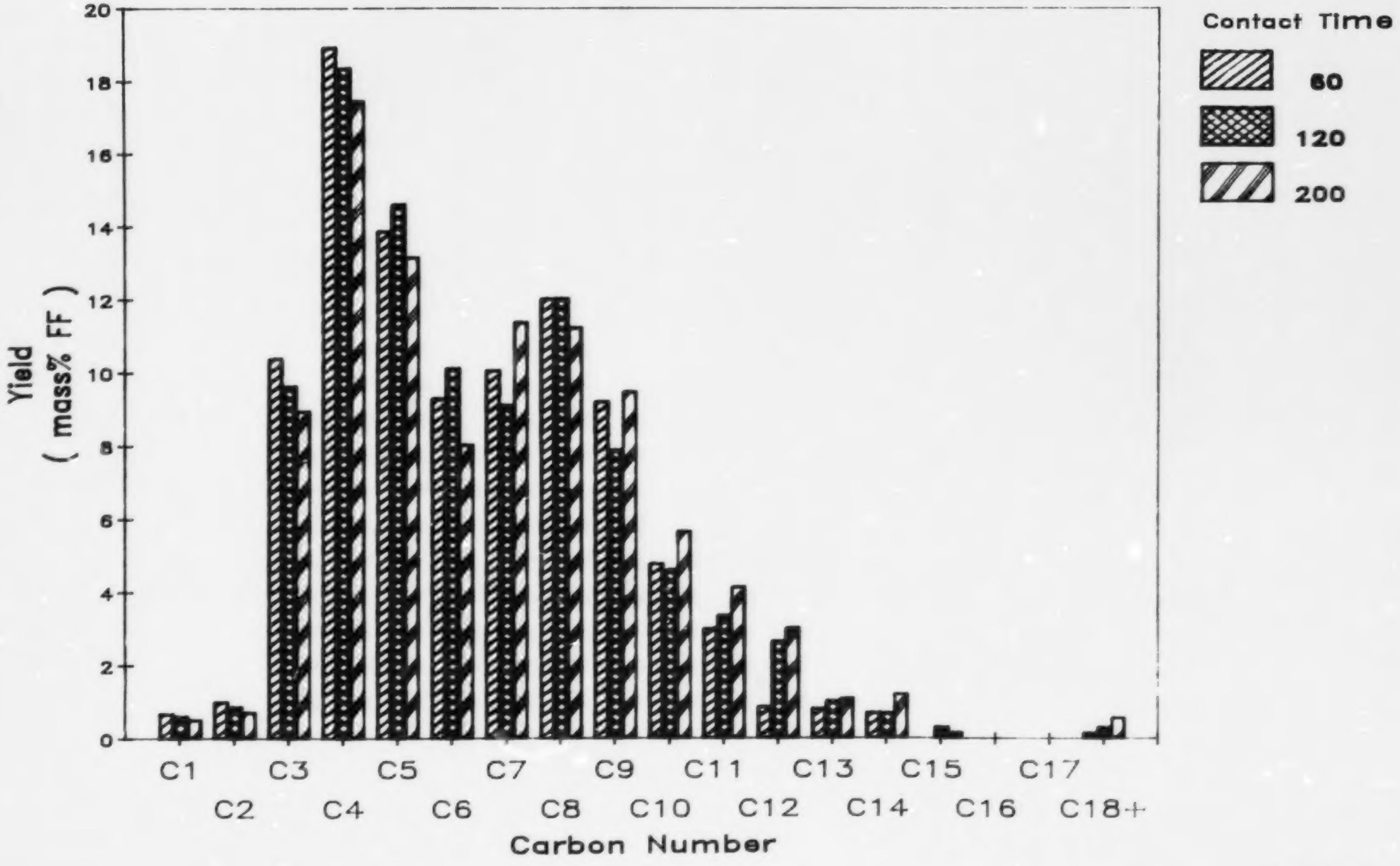
2,4,6,10-Tetramethylpentadecane



T2ATMPD

Task 2. Cracking Yields for other Hydrocarbons

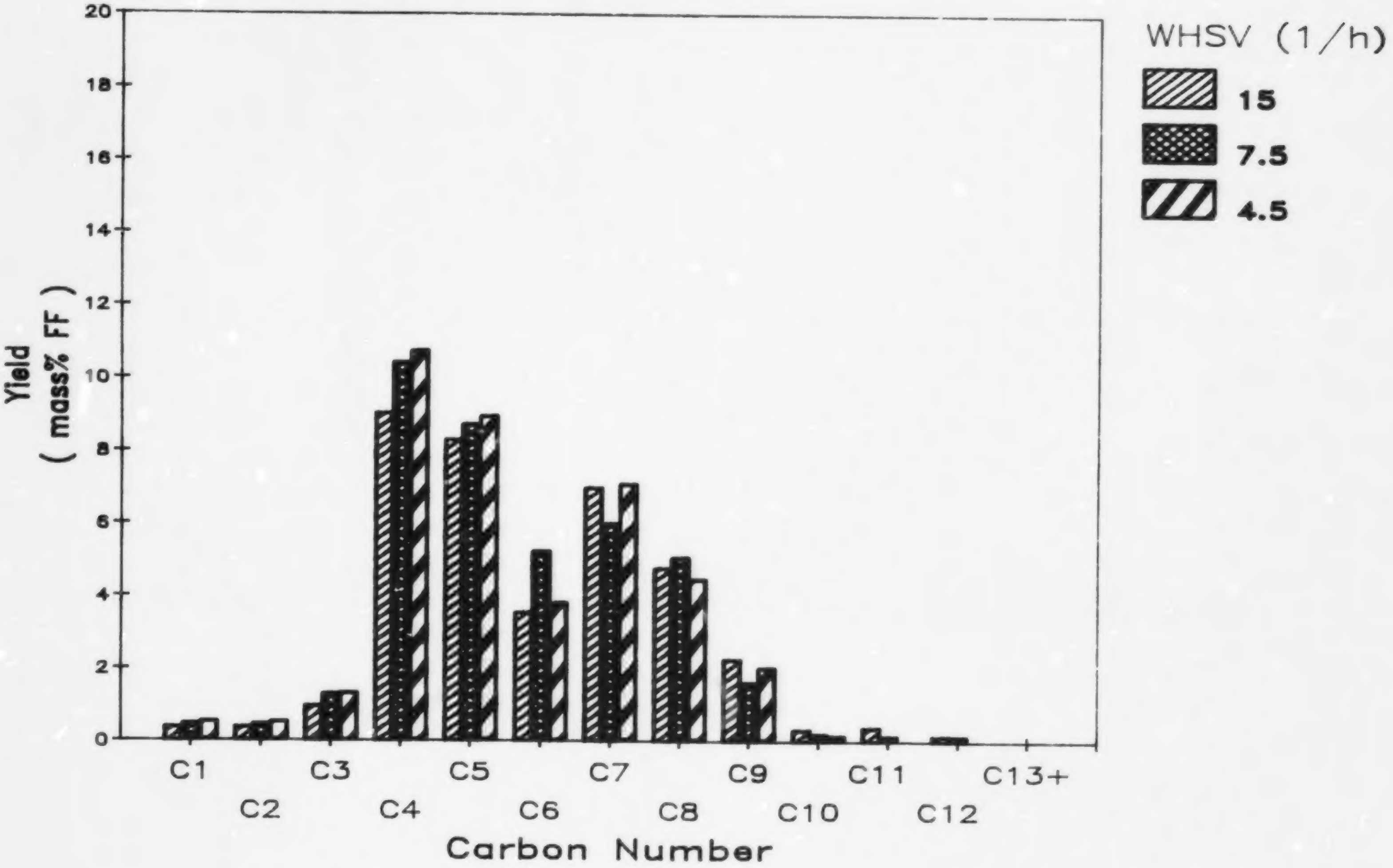
REACTOR EFFLUENT CARBON DISTRIBUTION
1 - Octadecene



T2C18CD

Task 2. Cracking Yields for other Hydrocarbons

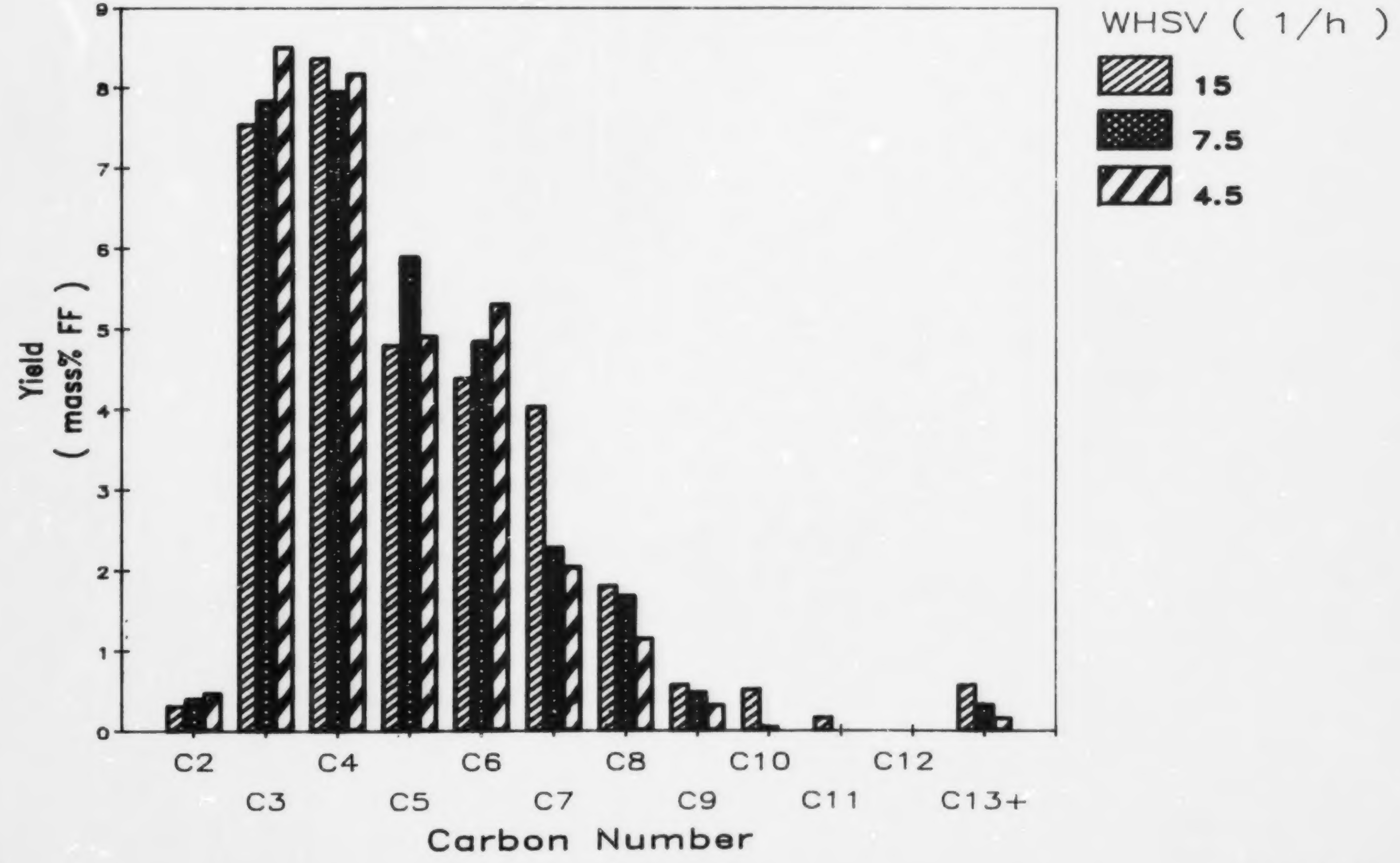
PARAFFIN DISTRIBUTION
1-Octadecene



T2PC18ENE

Task 2. Cracking Yields for other Hydrocarbons

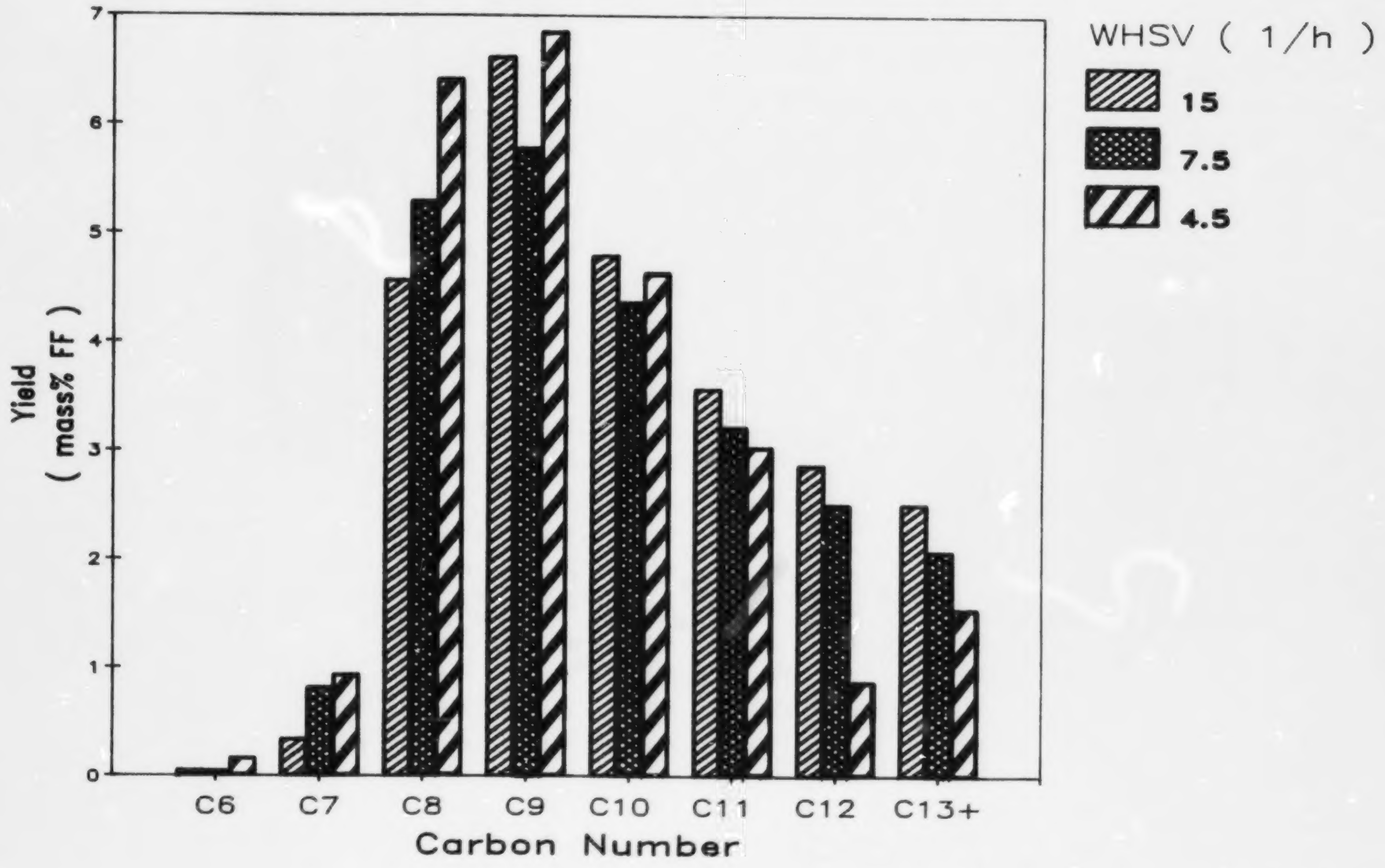
OLEFIN DISTRIBUTION
1-Octadecene



T2OC18ENE

Task 2. Cracking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION
1-Octadecene

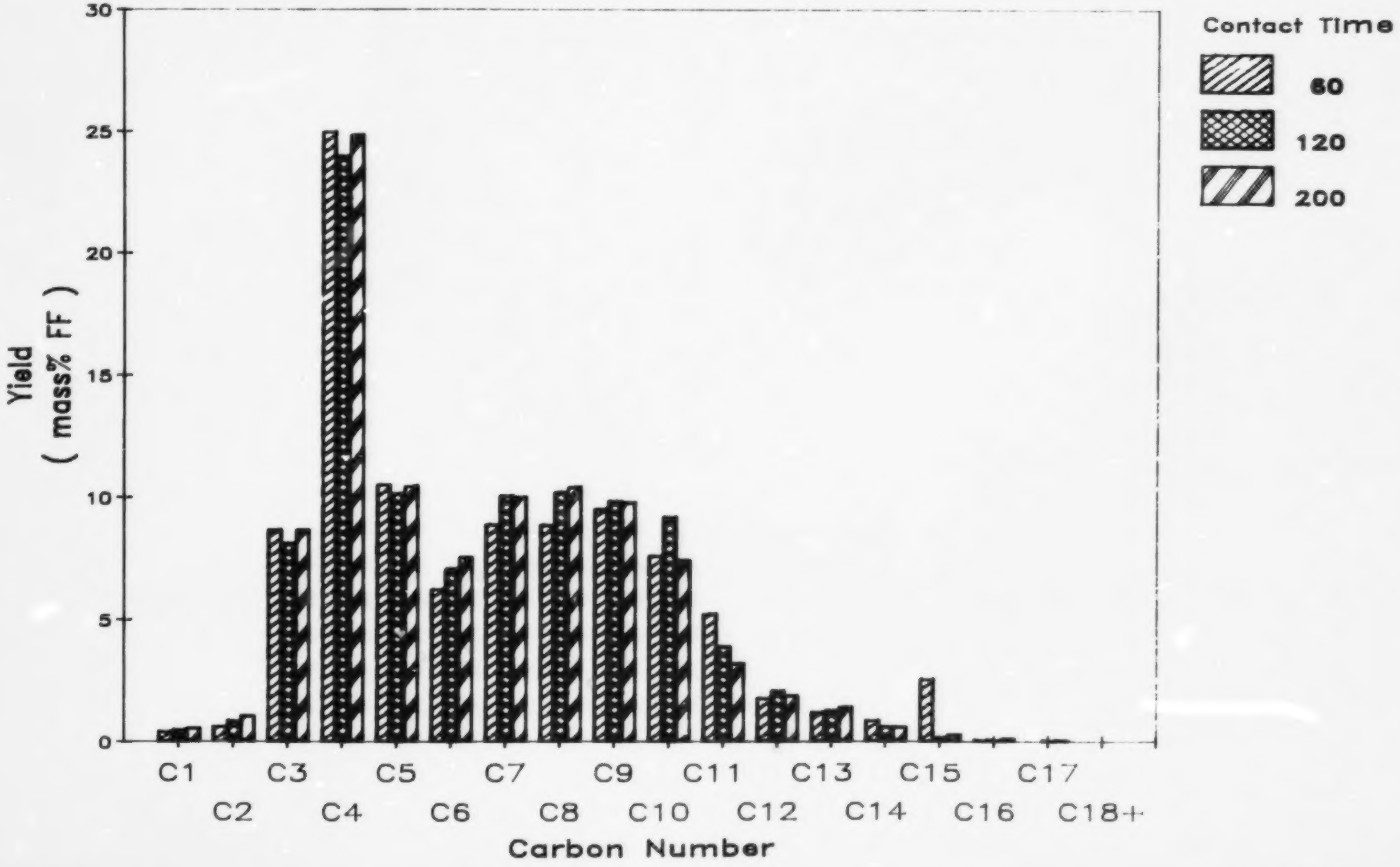


T2AC18ENE

Task 2. Cracking Yields for other Hydrocarbons

REACTOR EFFLUENT CARBON DISTRIBUTION

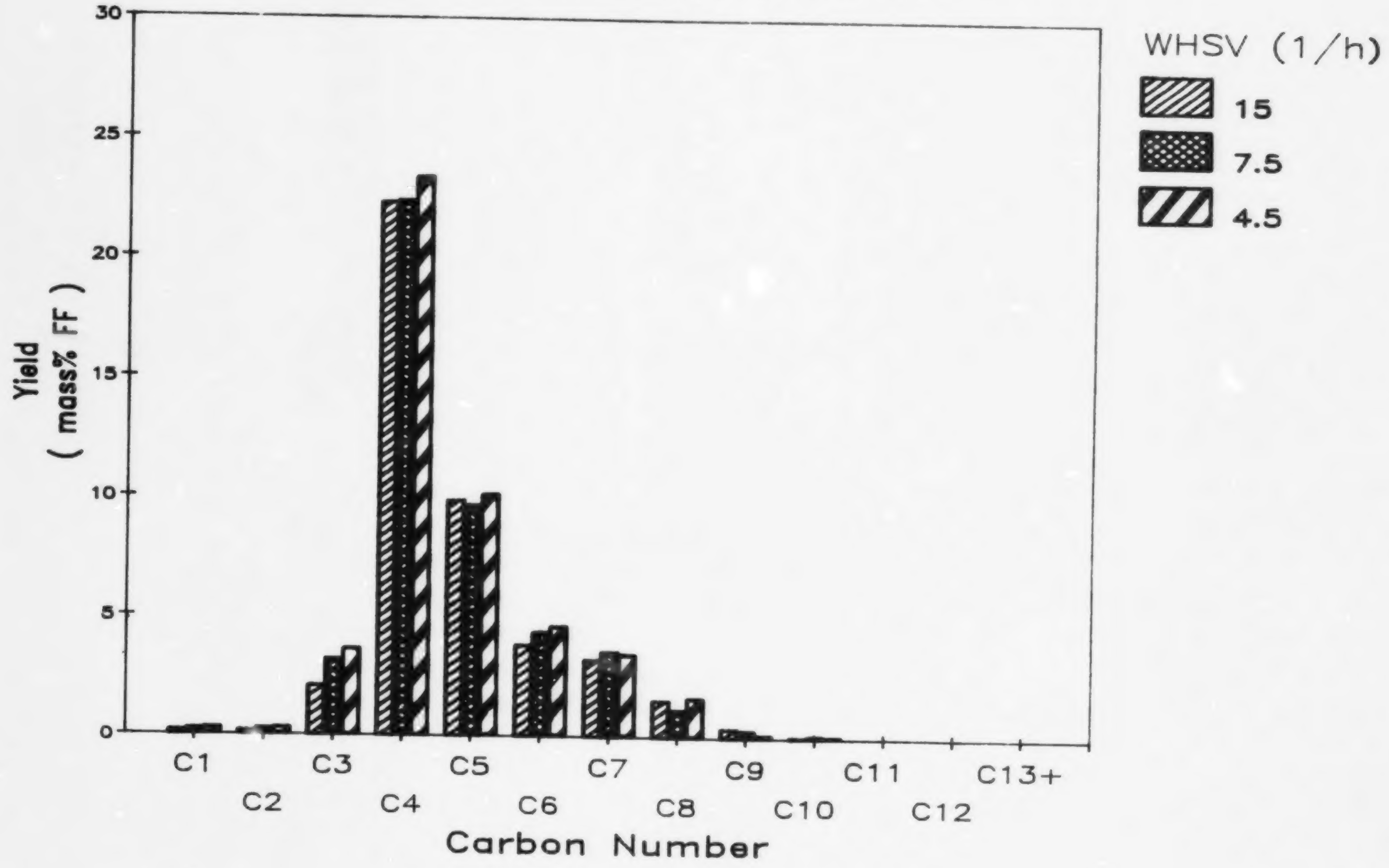
1,3,5 - Triisopropylcyclohexane



T2PCHCD

Task 2. Cracking Yields for other Hydrocarbons

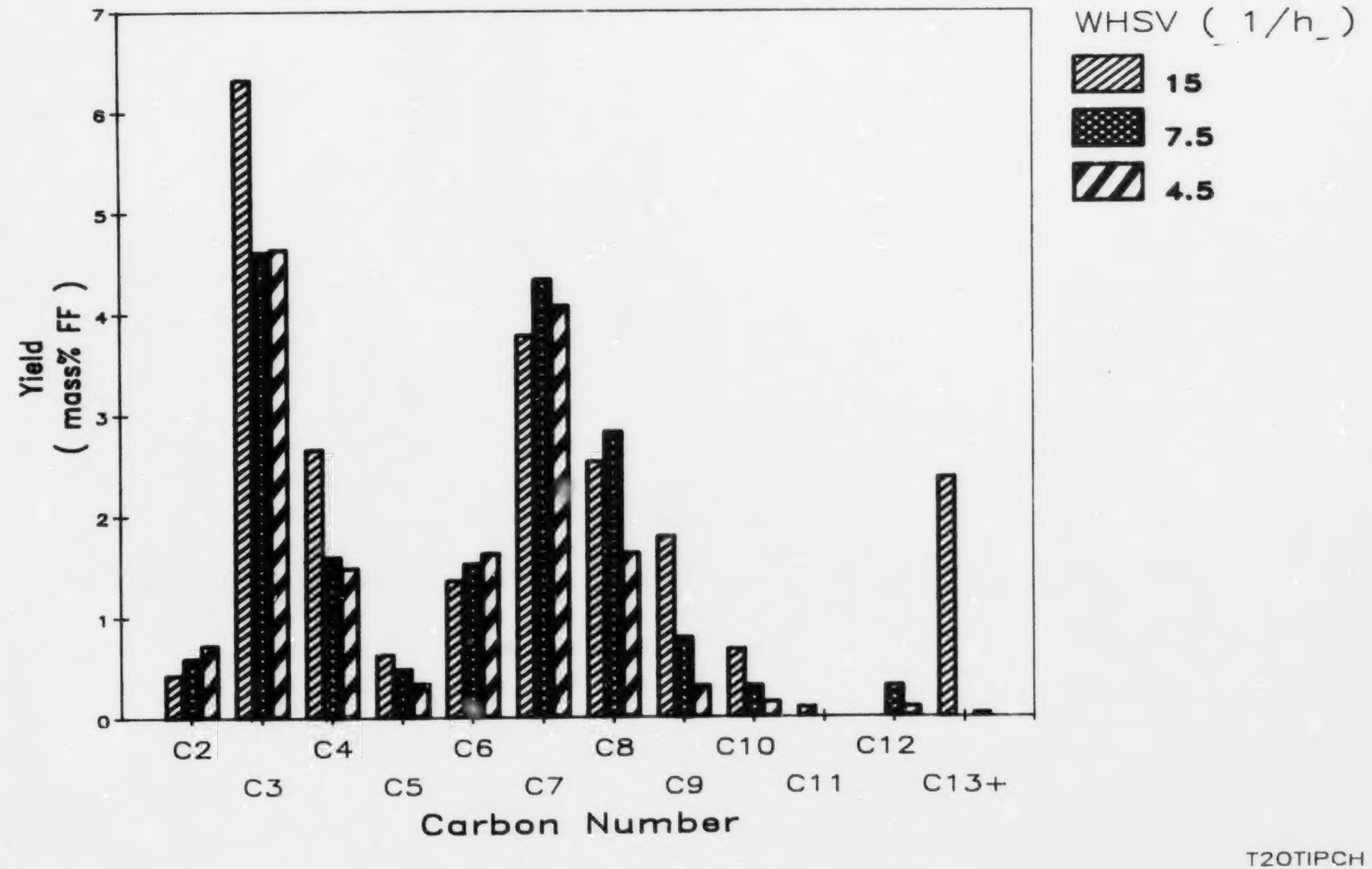
PARAFFIN DISTRIBUTION
1,3,5-Tri-i-Propylcyclohexane



Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION

1,3,5-Tri-I-Propylcyclohexane

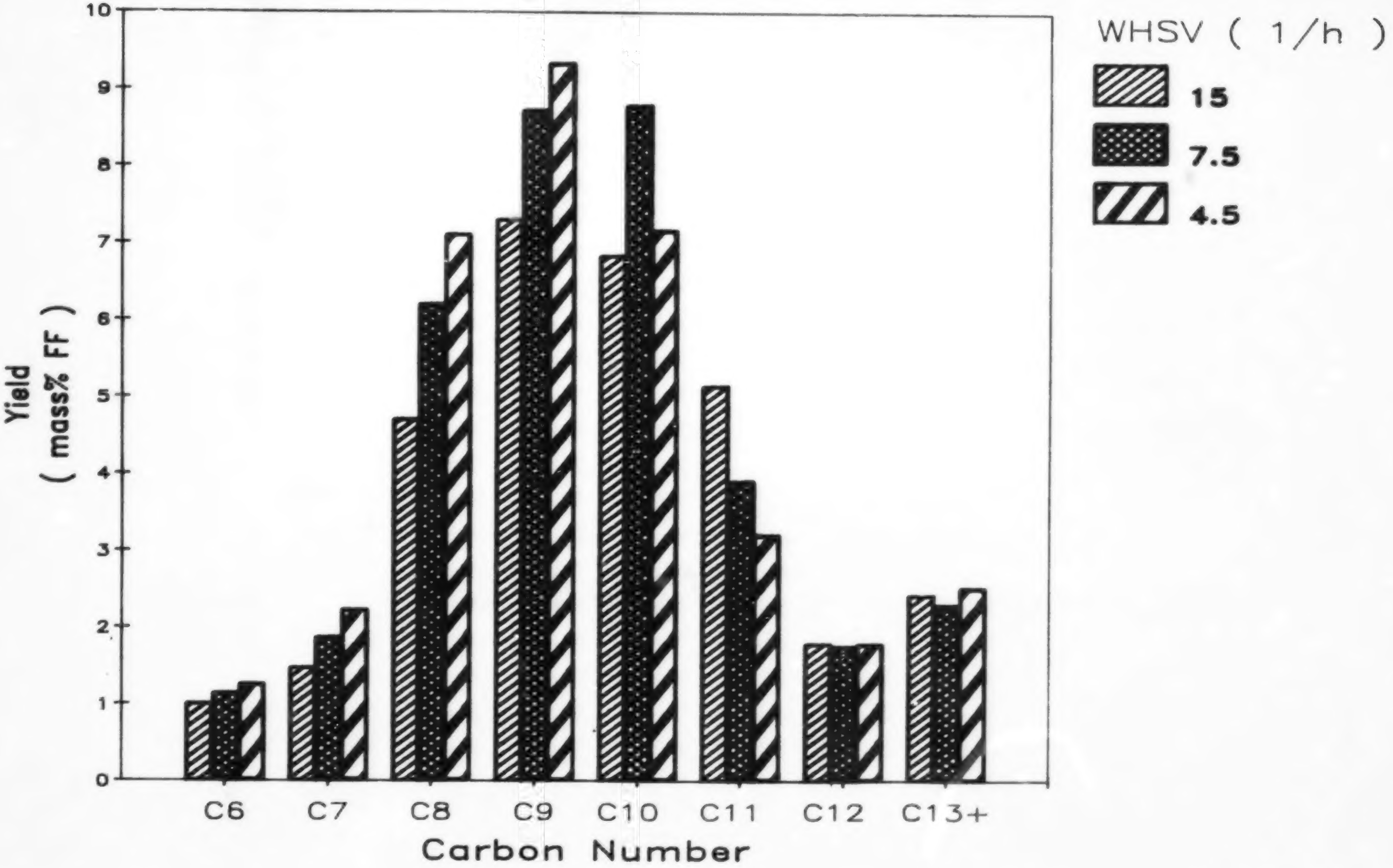


T2OTIPCH

Task 2. Cracking Yields for other Hydrocarbons

AROMATIC DISTRIBUTION

1,3,5-Tri-i-Propylcyclohexane

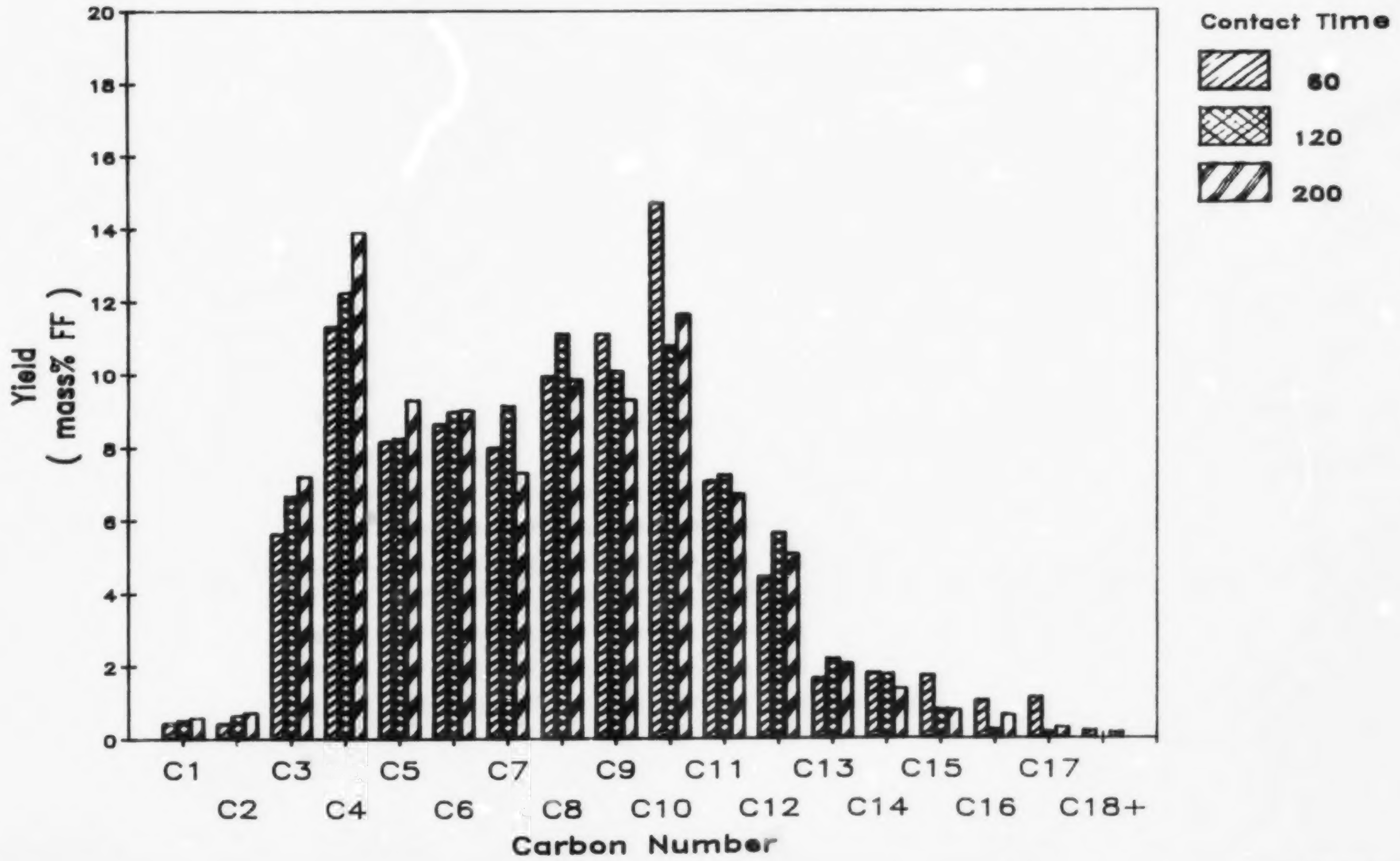


T2ATIPCH

Task 2. Cracking Yields for other Hydrocarbons

REACTOR EFFLUENT CARBON DISTRIBUTION

1 - Phenyldodecane

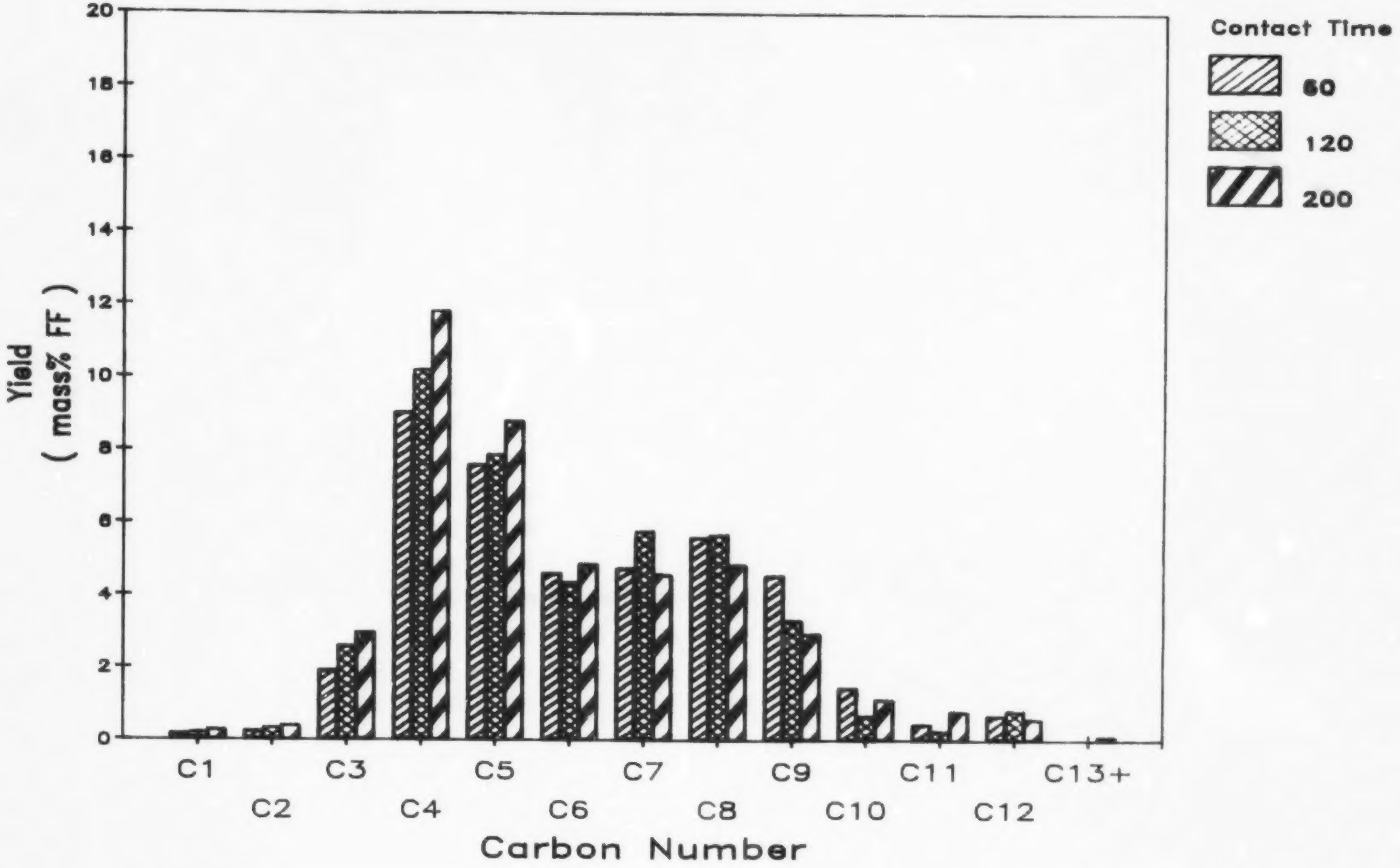


T21P12CD

Task 2. Cracking Yields for other Hydrocarbons

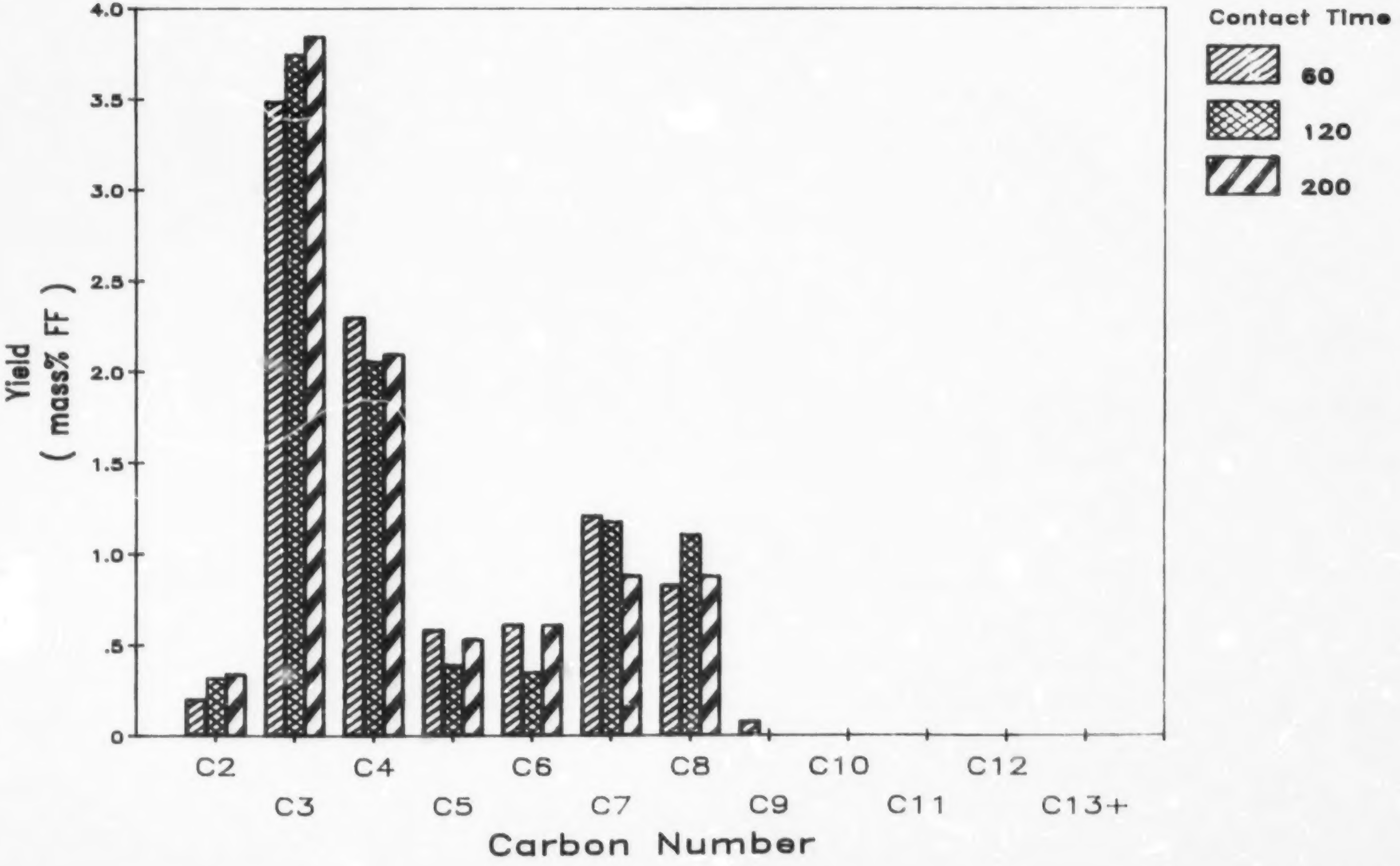
PARAFFIN DISTRIBUTION

1-Phenyldodecane



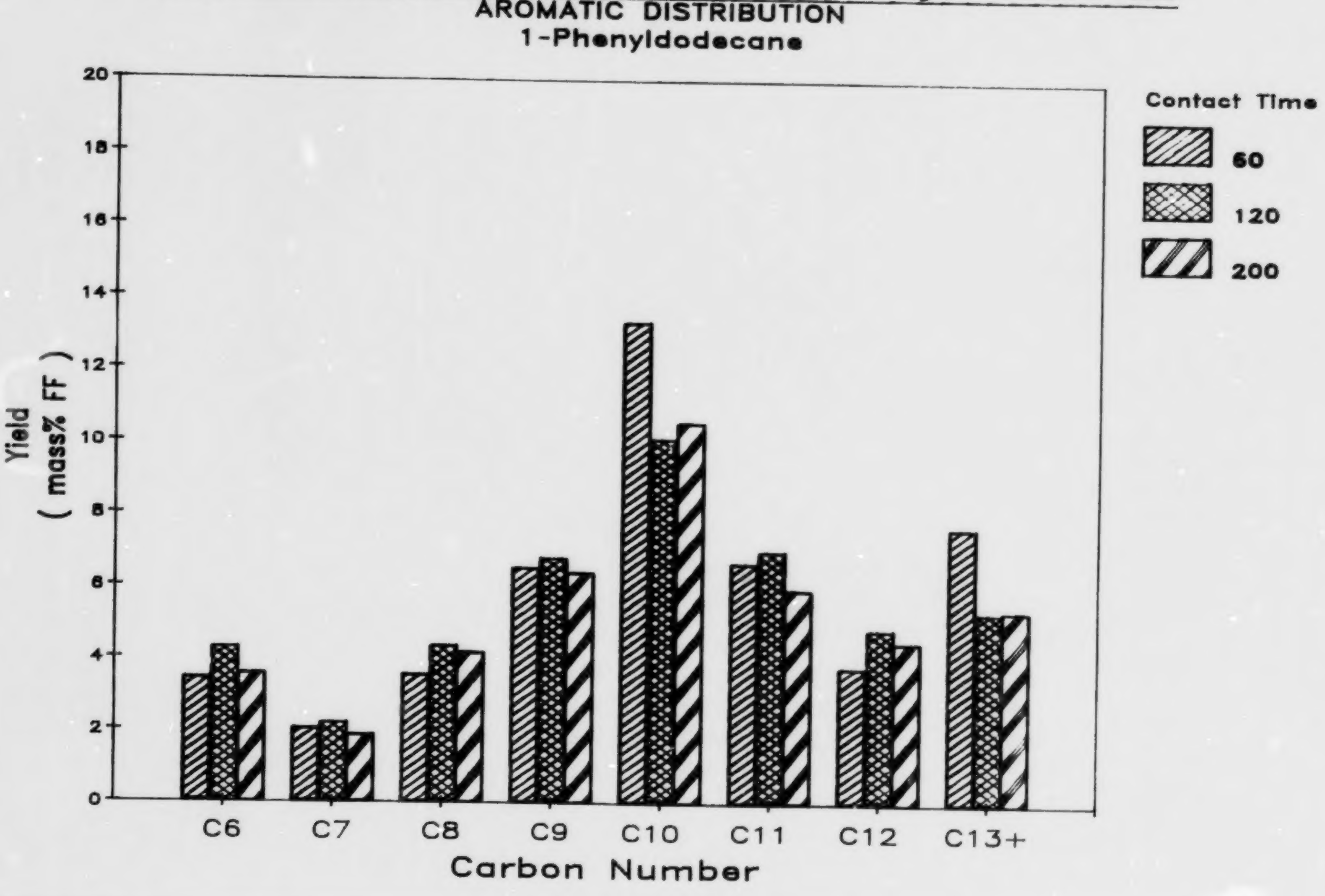
Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION
1-Phenyldodecane



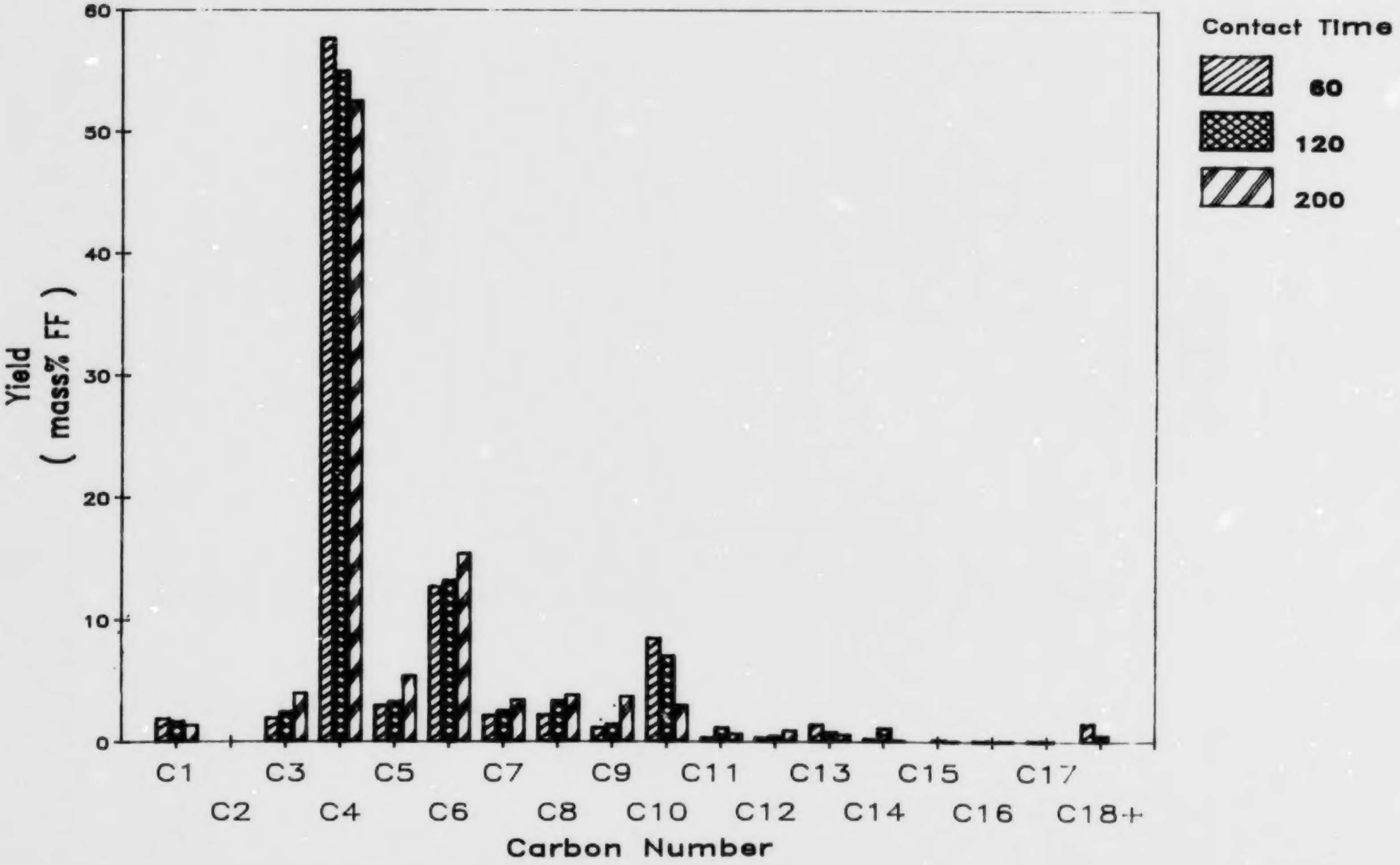
T201PC12

Task 2. Cracking Yields for other Hydrocarbons



Task 2. Cracking Yields for other Hydrocarbons

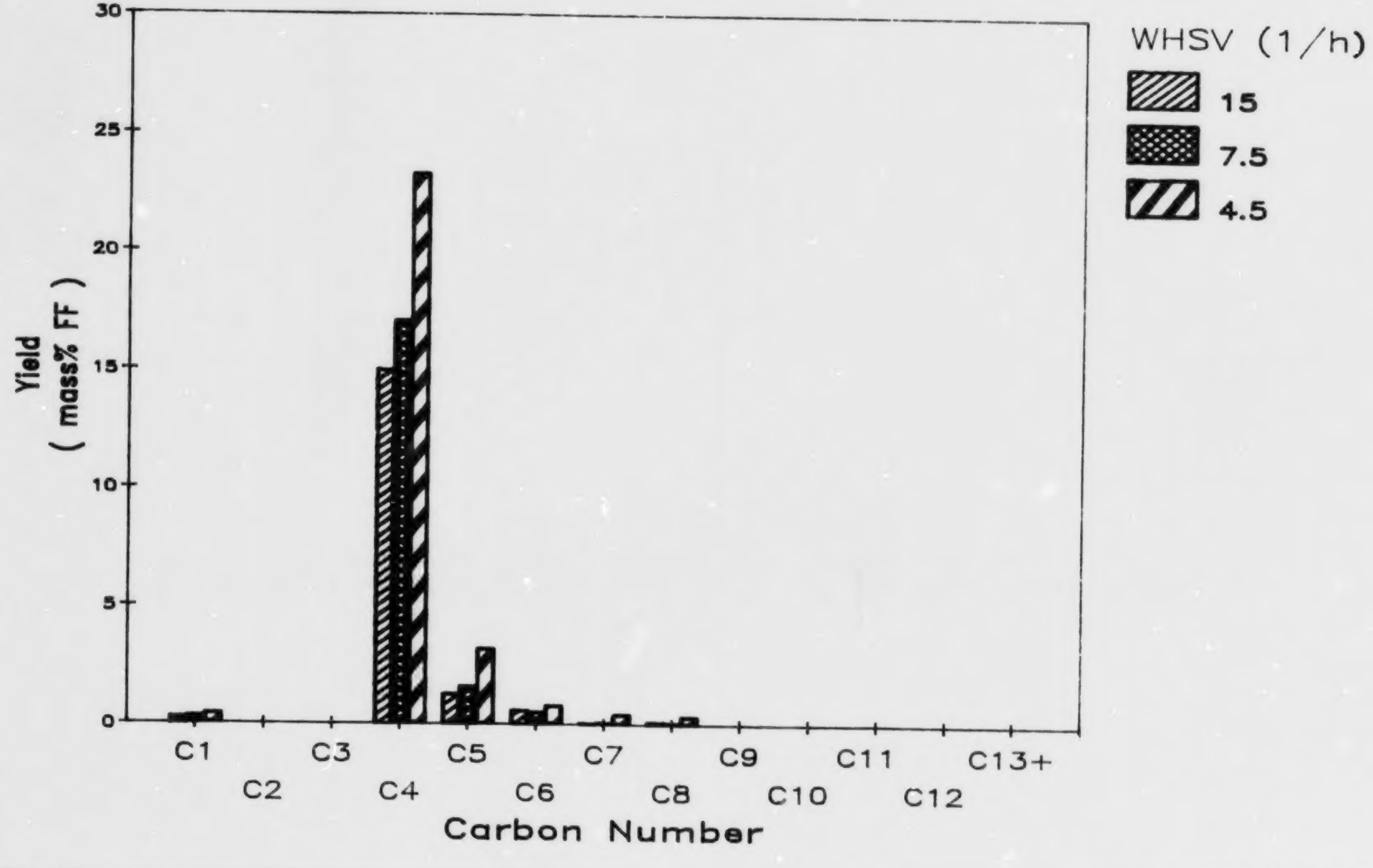
REACTOR EFFLUENT CARBON DISTRIBUTION
1,3,5 - Tri-t-Butylbenzene



T2TTBBCD

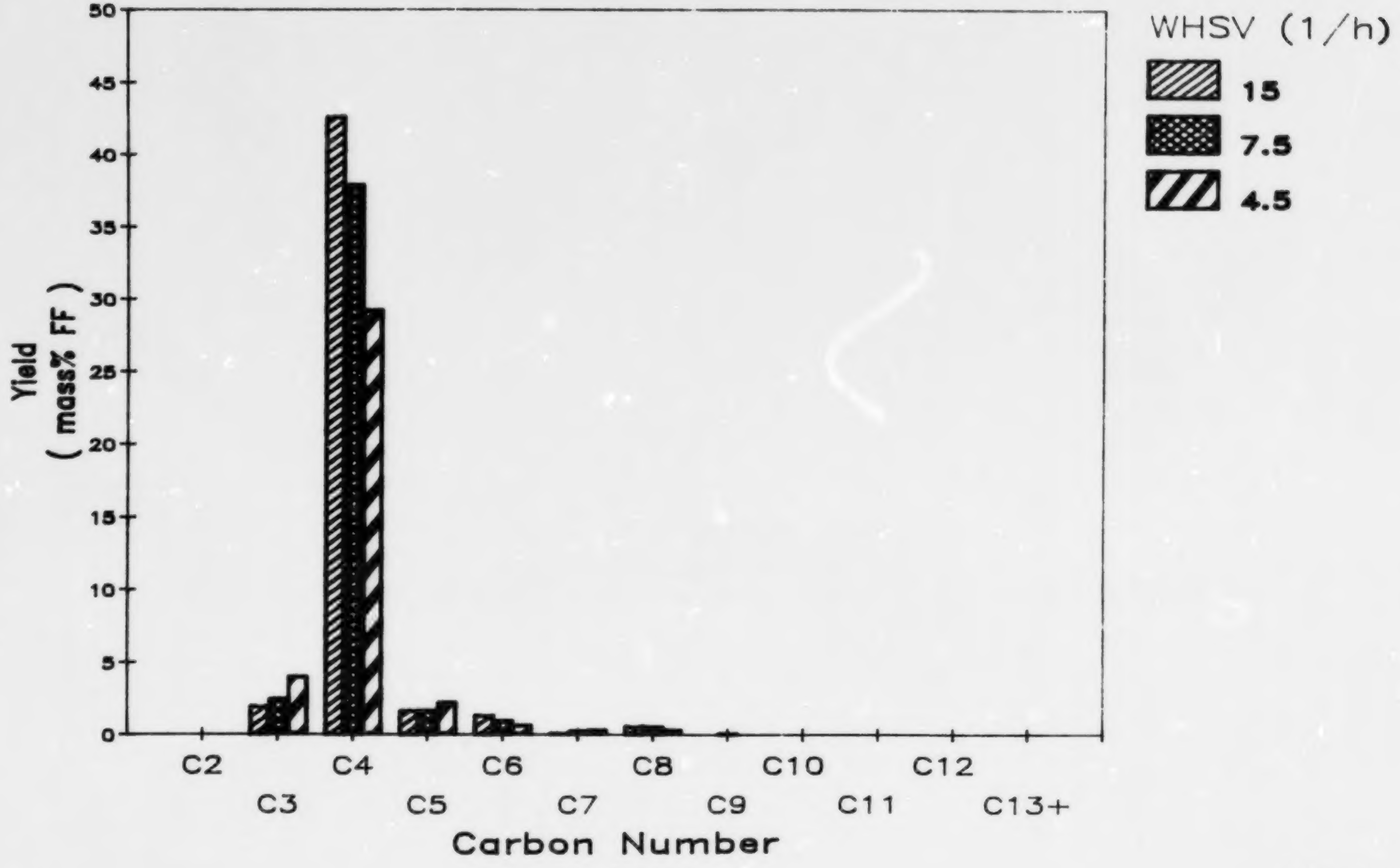
Task 2. Cracking Yields for other Hydrocarbons

PARAFFIN DISTRIBUTION
1,3,5-Tri-t-Butylbenzene



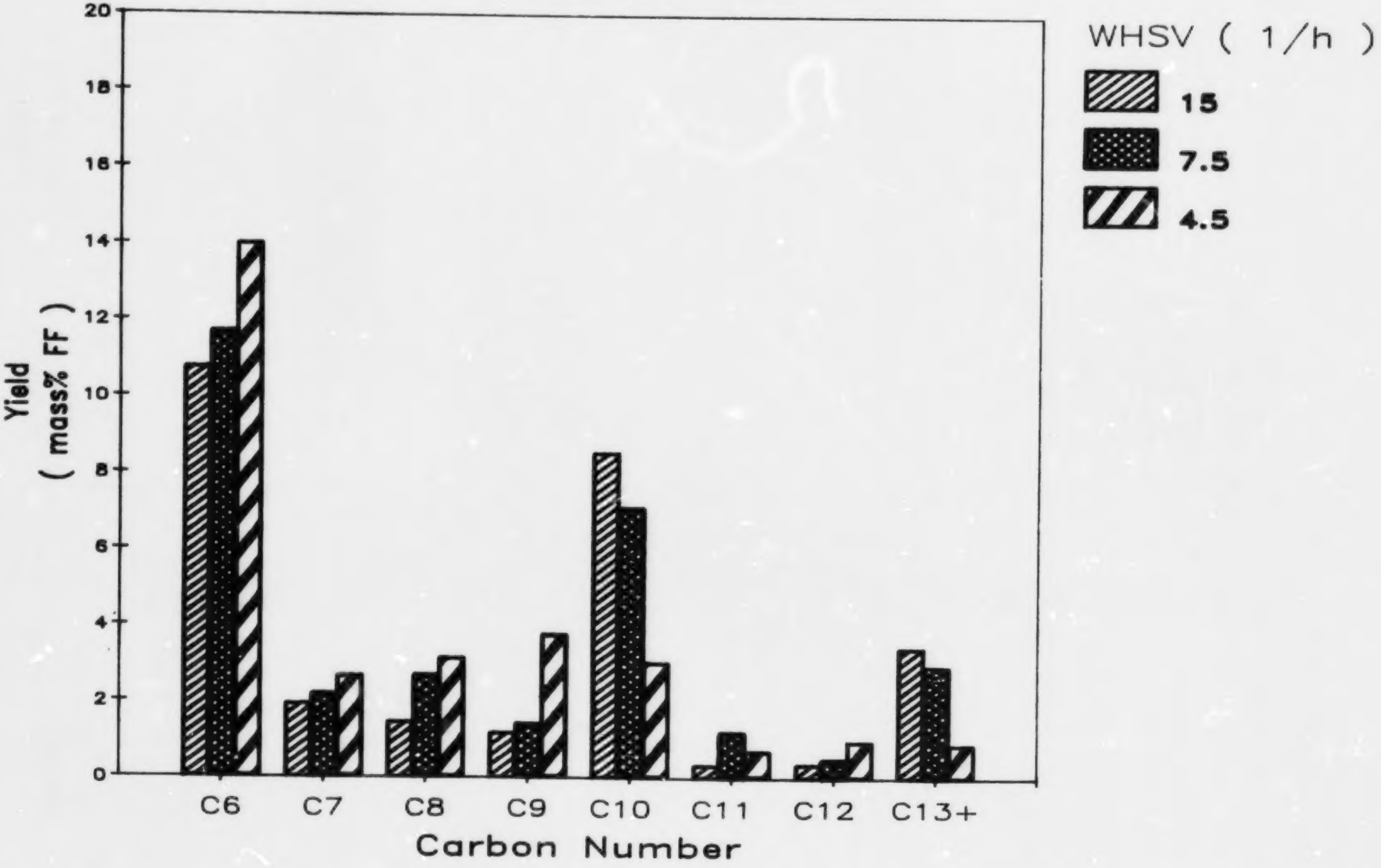
Task 2. Cracking Yields for other Hydrocarbons

OLEFIN DISTRIBUTION
1,3,5-Tri-t-Butylbenzene



T20TTBB

Task 2. Cracking Yields for other Hydrocarbons



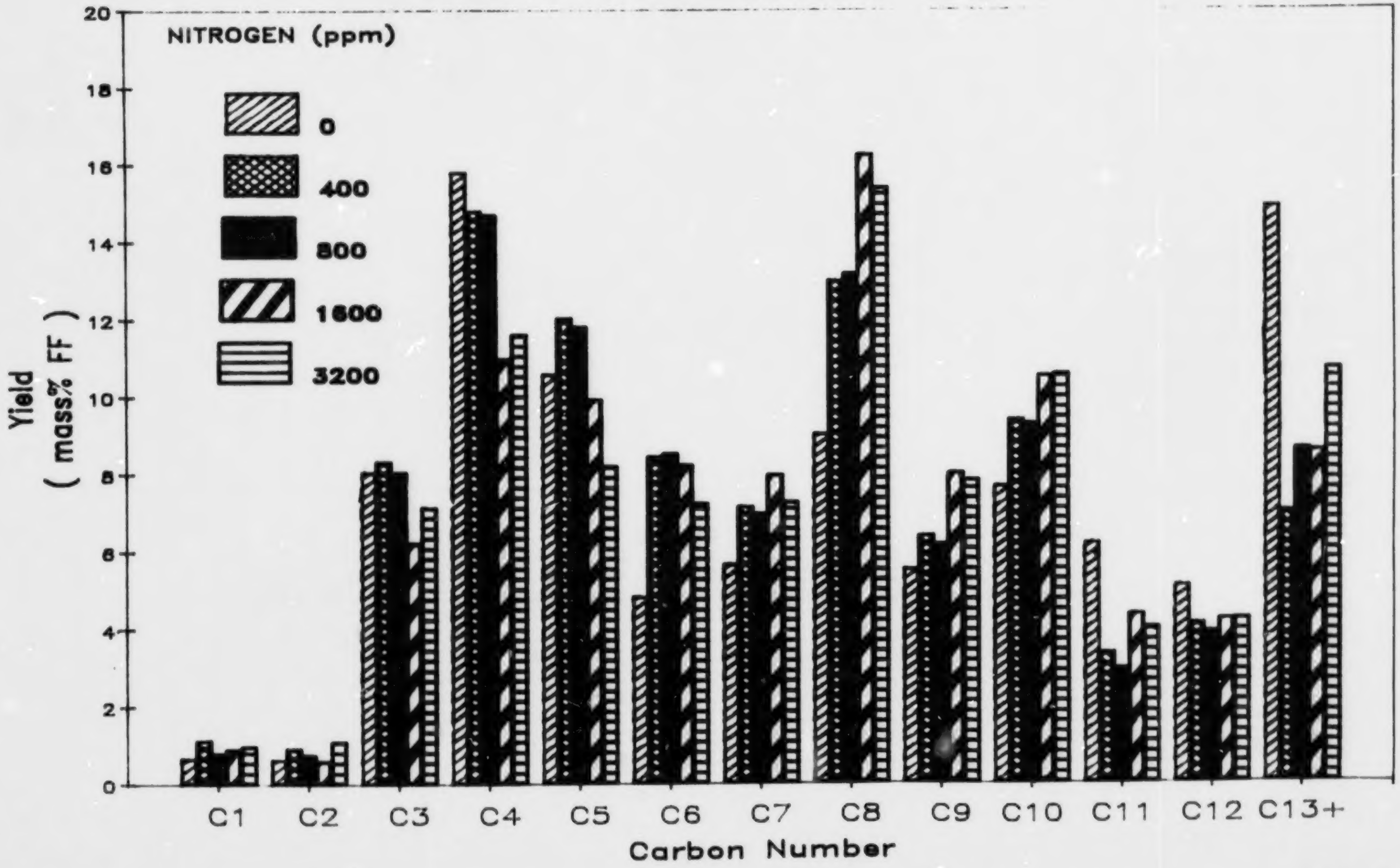
AROMATIC DISTRIBUTION

1,3,5-Tri-t-Butylbenzene

Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

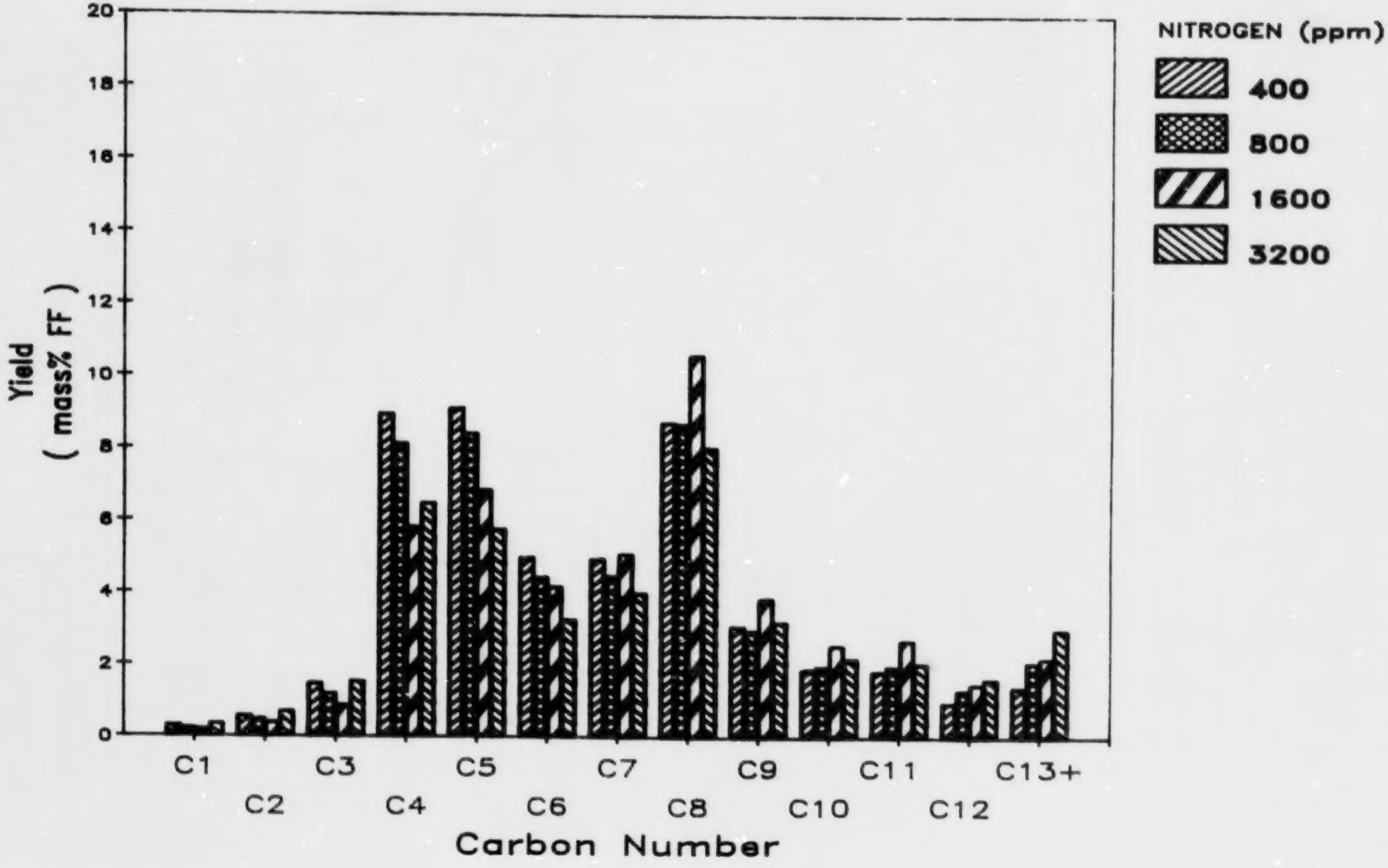
Blend A



T3AACD

Task 3.A. Effects of Nitrogen Poisoning

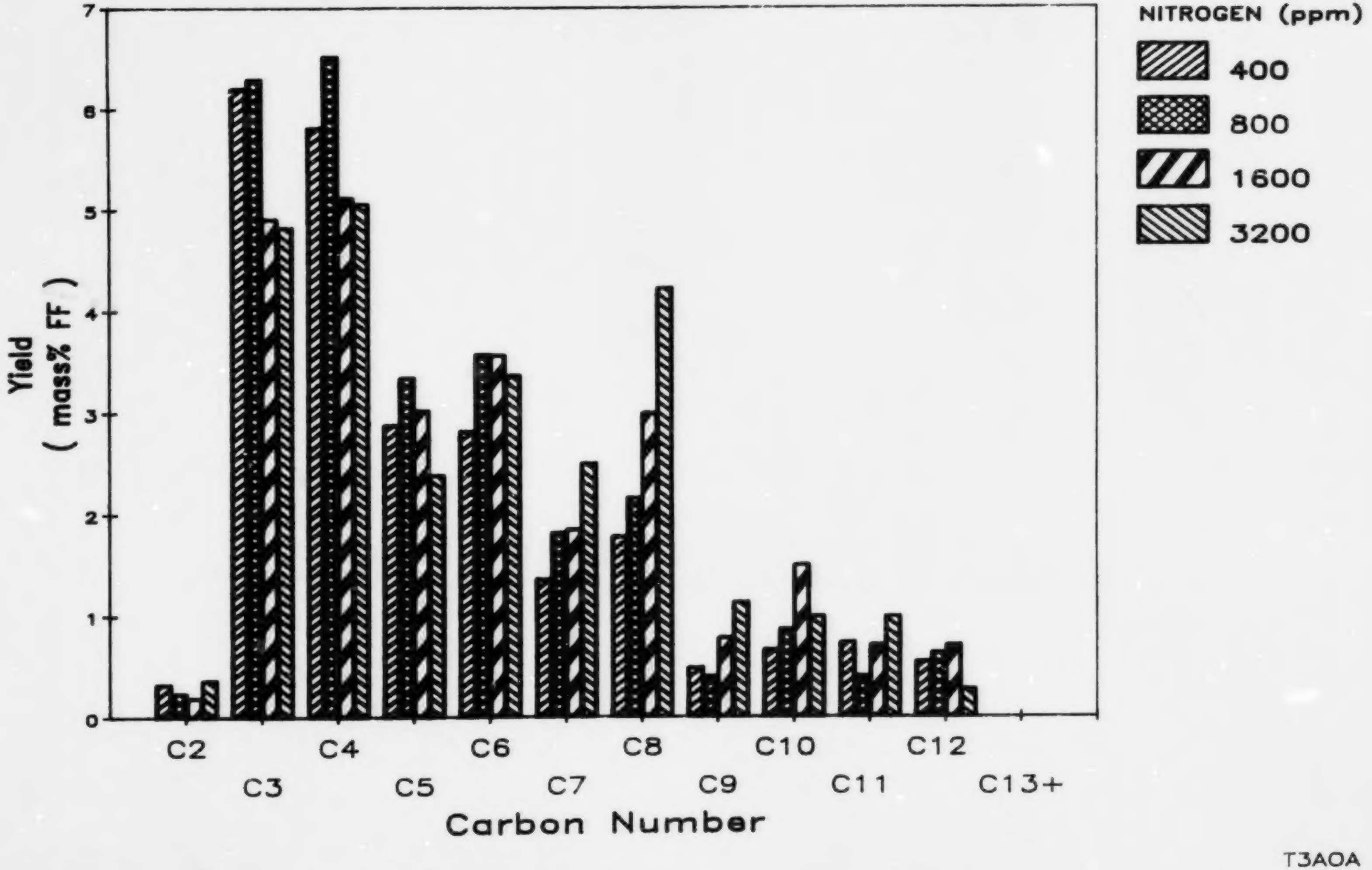
PARAFFIN DISTRIBUTION
Blend A



T3APA

Task 3.A. Effects of Nitrogen Poisoning

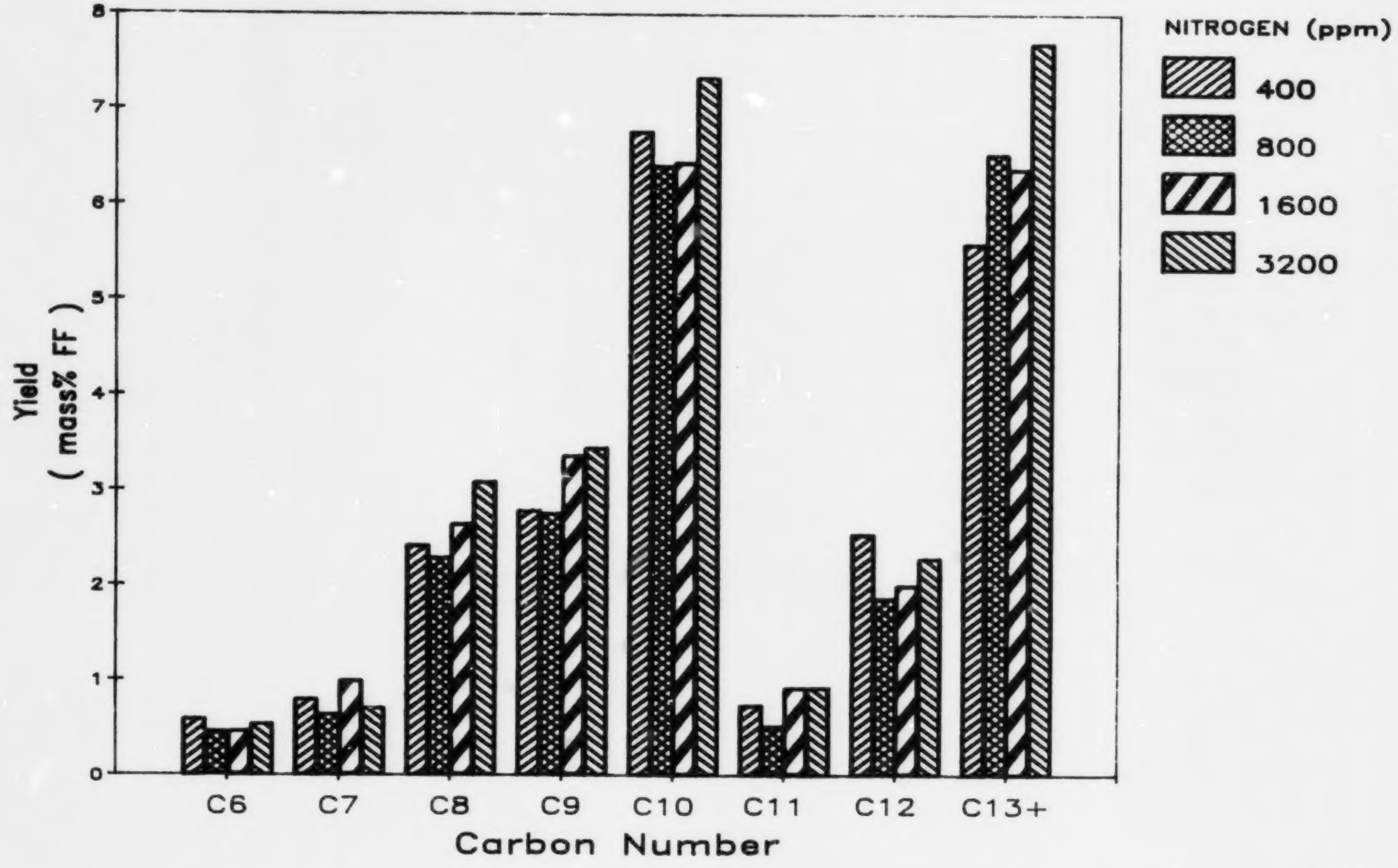
OLEFIN DISTRIBUTION
Blend A



T3AOA

Task 3.A. Effects of Nitrogen Poisoning

AROMATIC DISTRIBUTION
Blend A

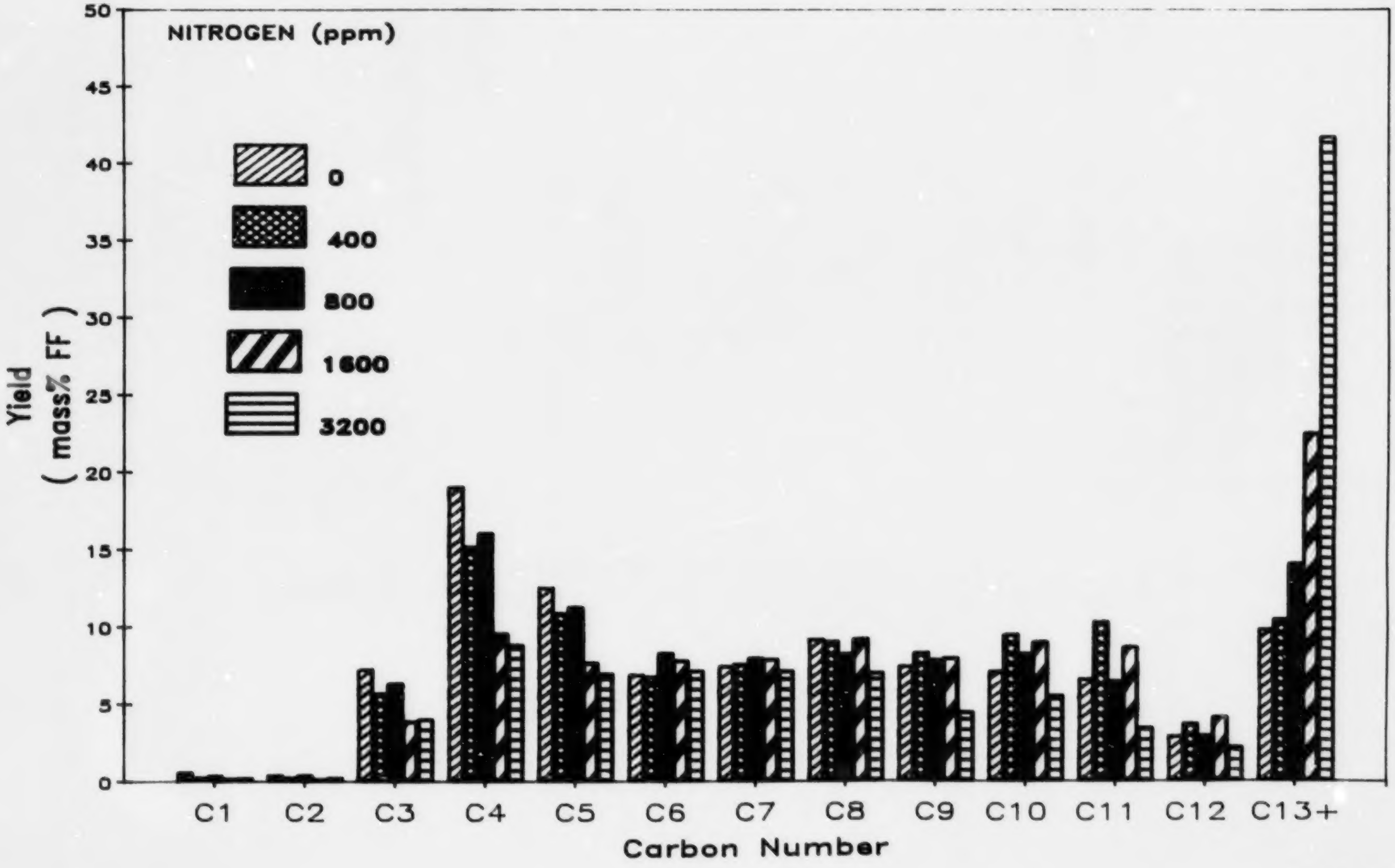


T3AAA

Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

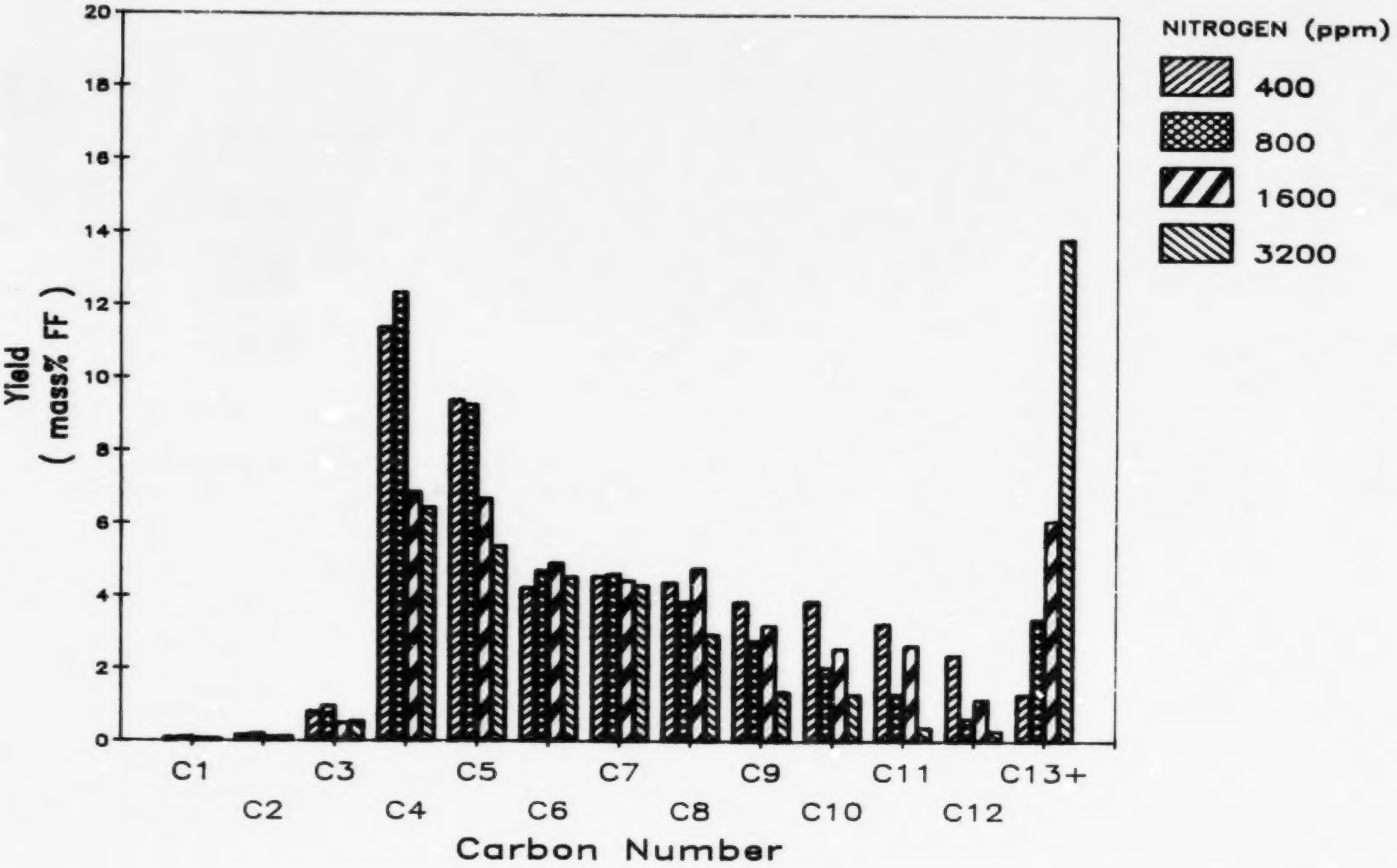
Blend B



T3ABCD

Task 3.A. Effects of Nitrogen Poisoning

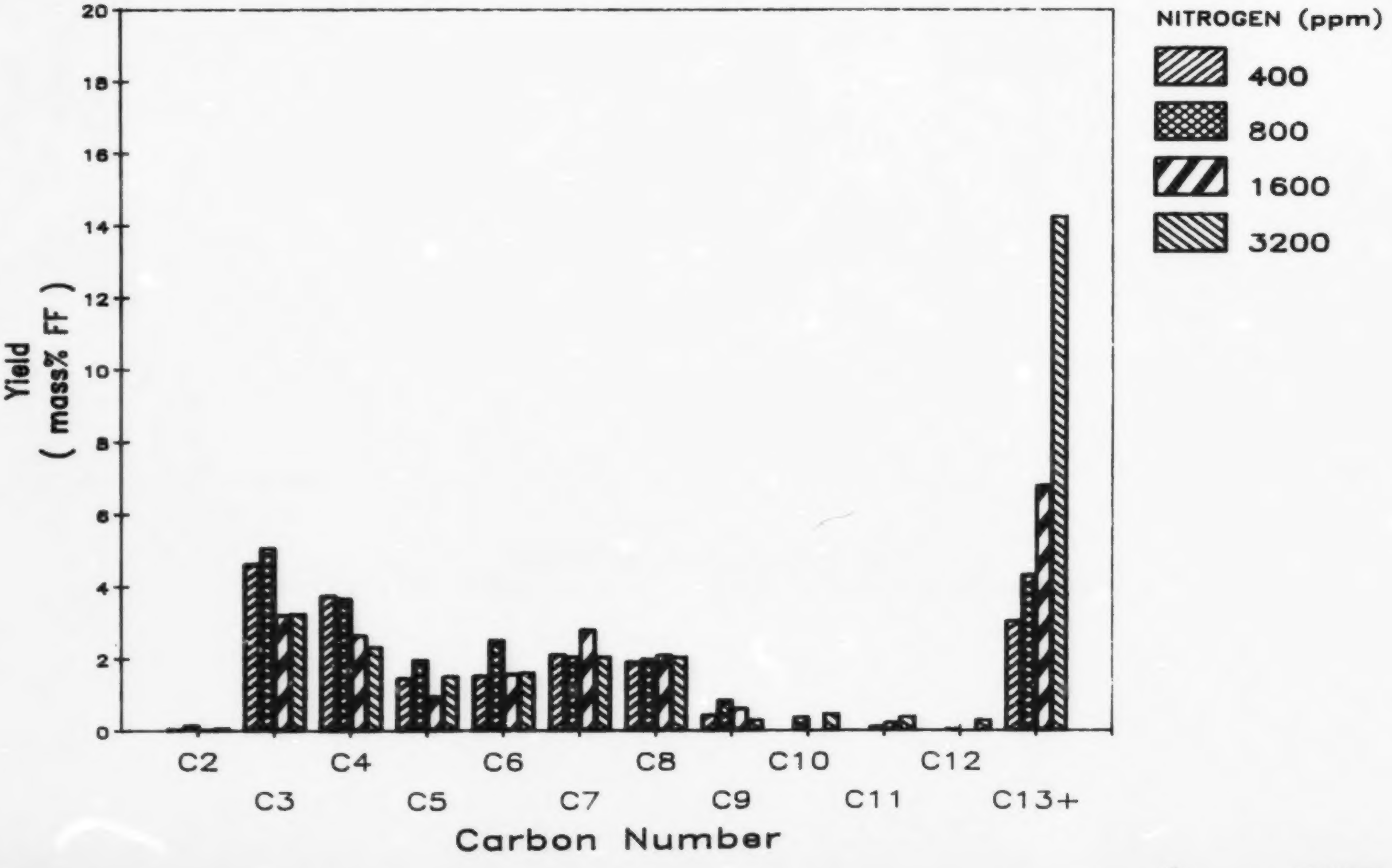
PARAFFIN DISTRIBUTION
Blend B



Task 3.A. Effects of Nitrogen Poisoning

OLEFIN DISTRIBUTION

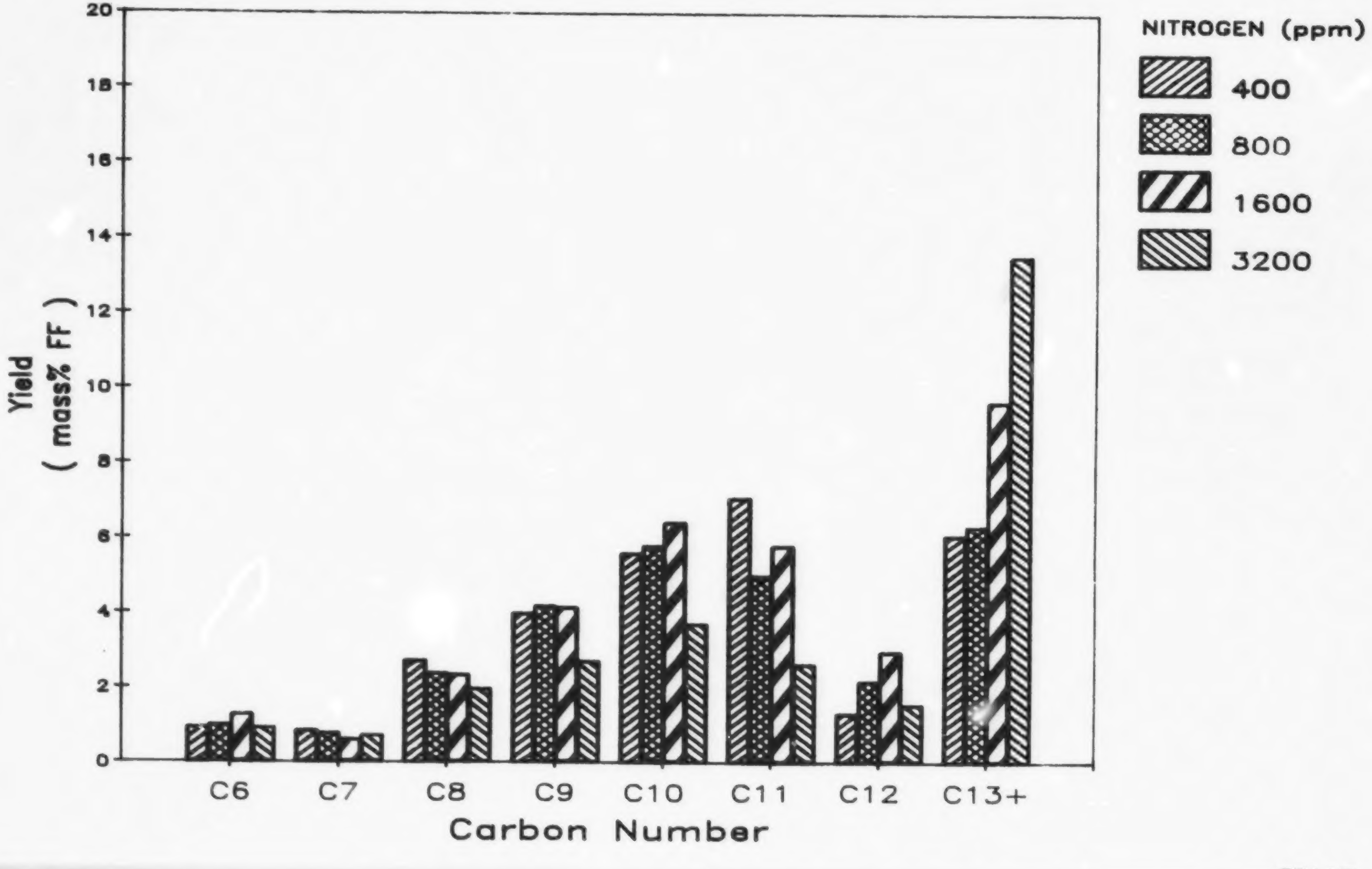
Blend B



T3AOB

Task 3.A. Effects of Nitrogen Poisoning

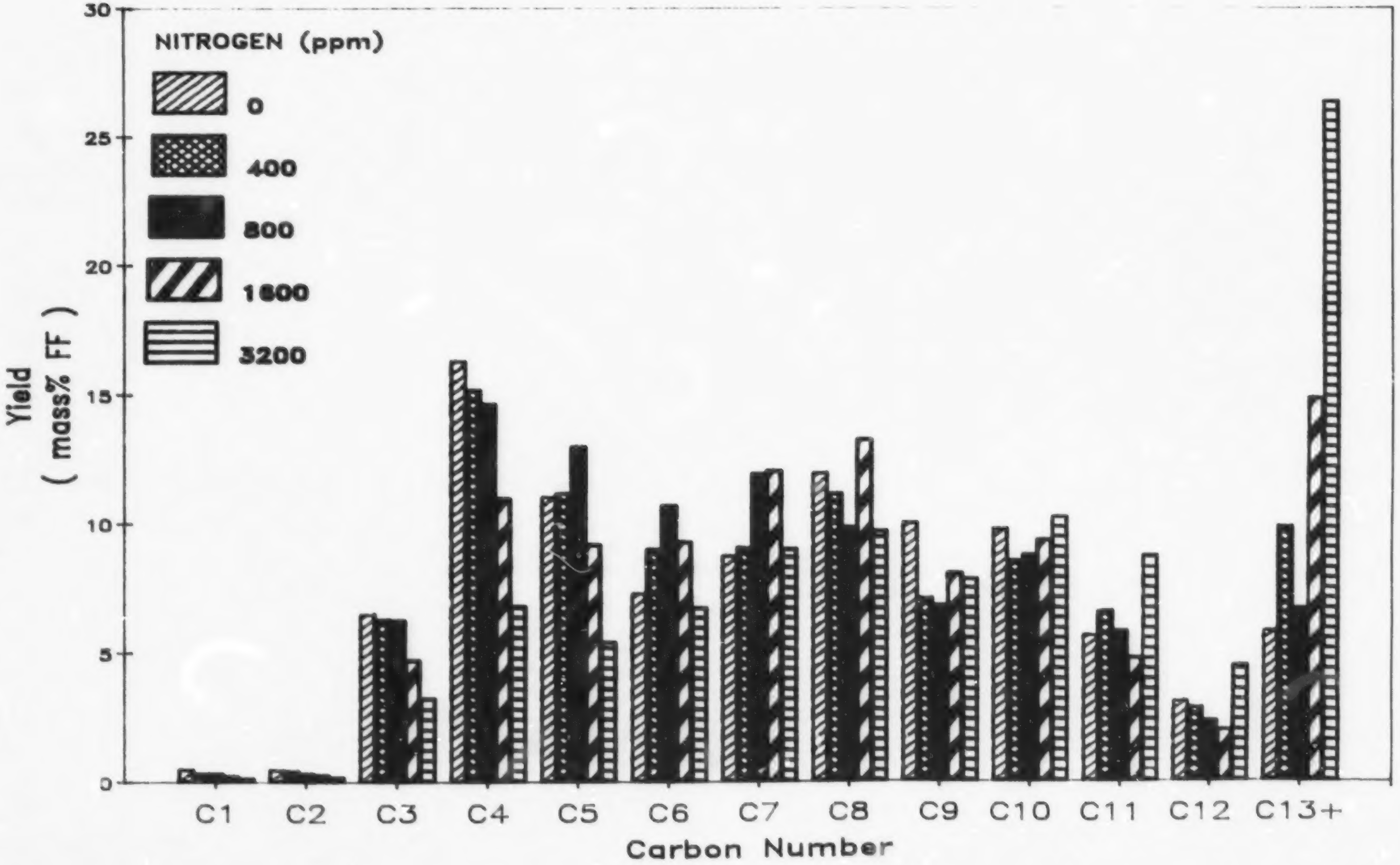
AROMATIC DISTRIBUTION
Blend B



Task 3.A. Effects of Nitrogen Poisoning

REACTOR EFFLUENT CARBON DISTRIBUTION

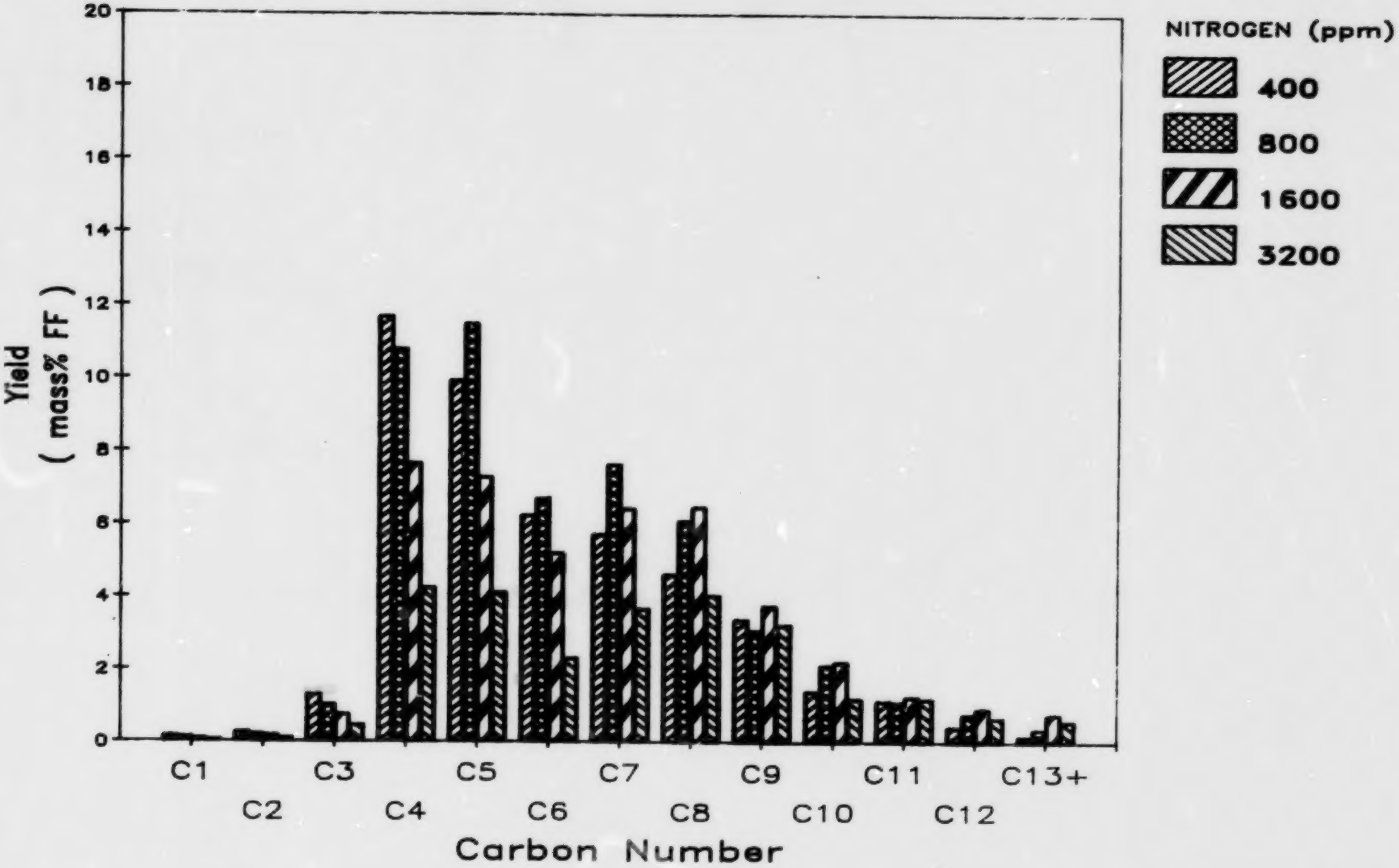
Blend C



T3ACCD

Task 3.A. Effects of Nitrogen Poisoning

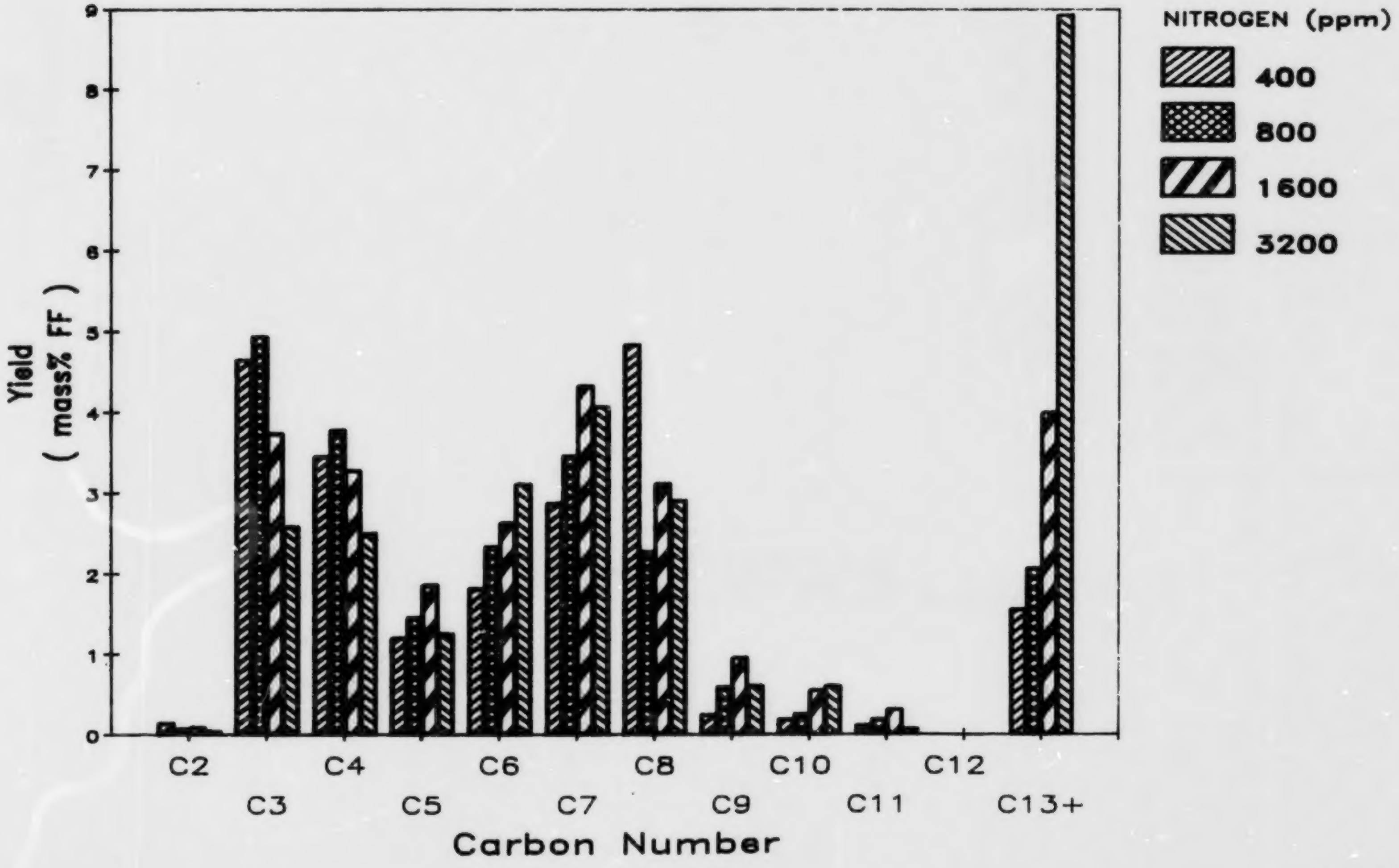
PARAFFIN DISTRIBUTION
Blend C



T3APC

Task 3.A. Effects of Nitrogen Poisoning

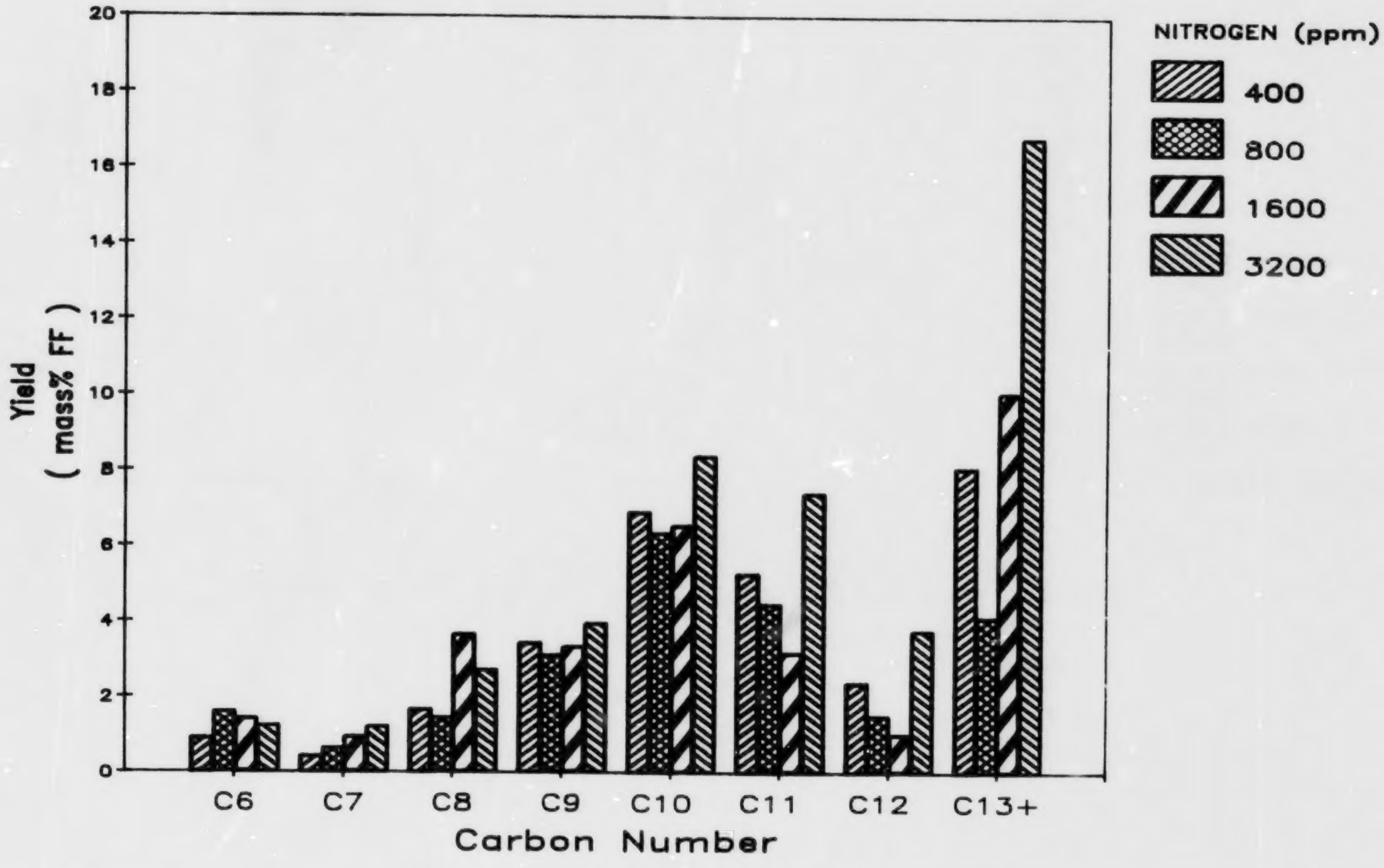
OLEFIN DISTRIBUTION
Blend C



T3AOC

Task 3.A. Effects of Nitrogen Poisoning

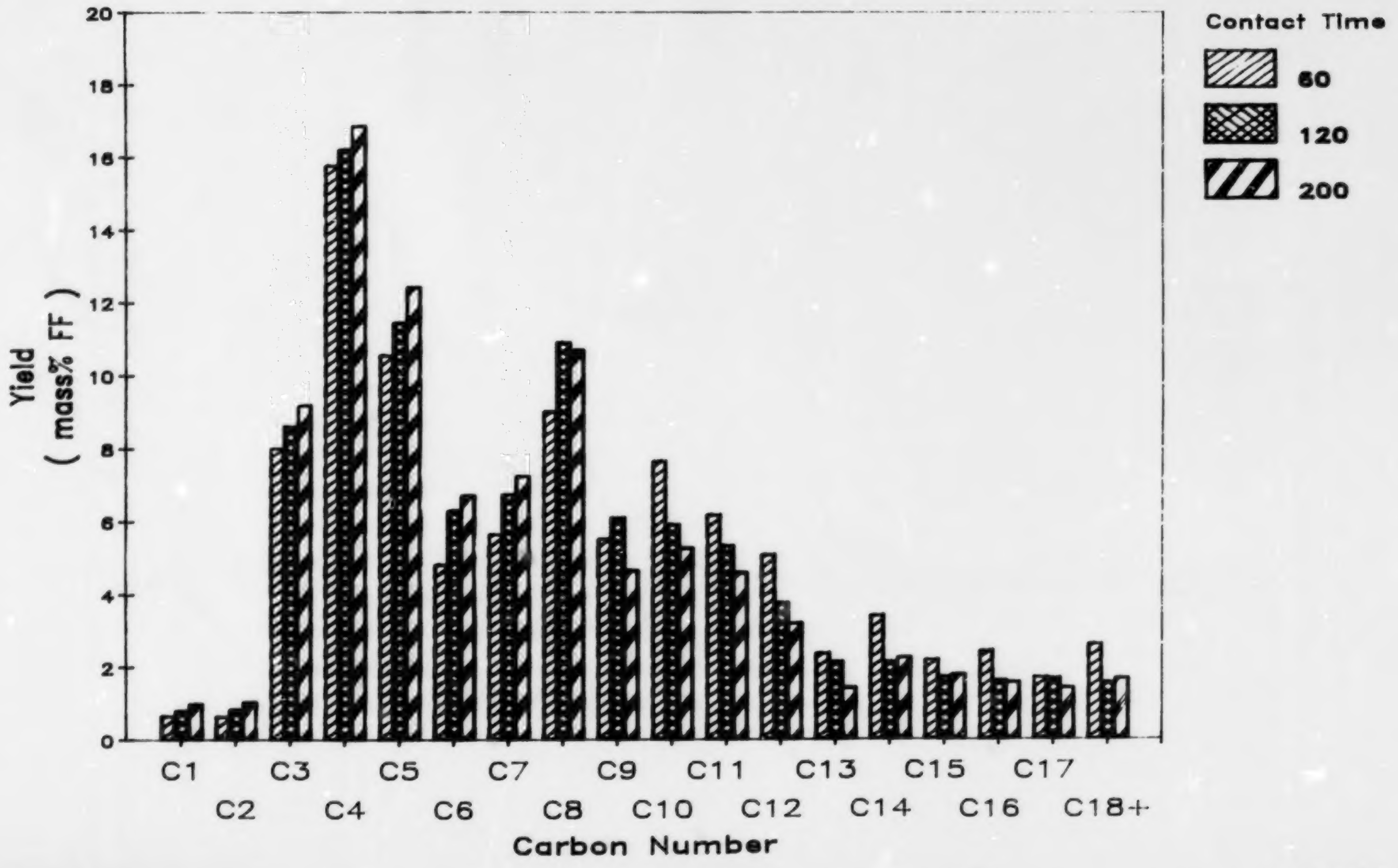
AROMATIC DISTRIBUTION
Blend C



Task 4. Key Component Blends & Synergistic Effects

REACTOR EFFLUENT CARBON DISTRIBUTION

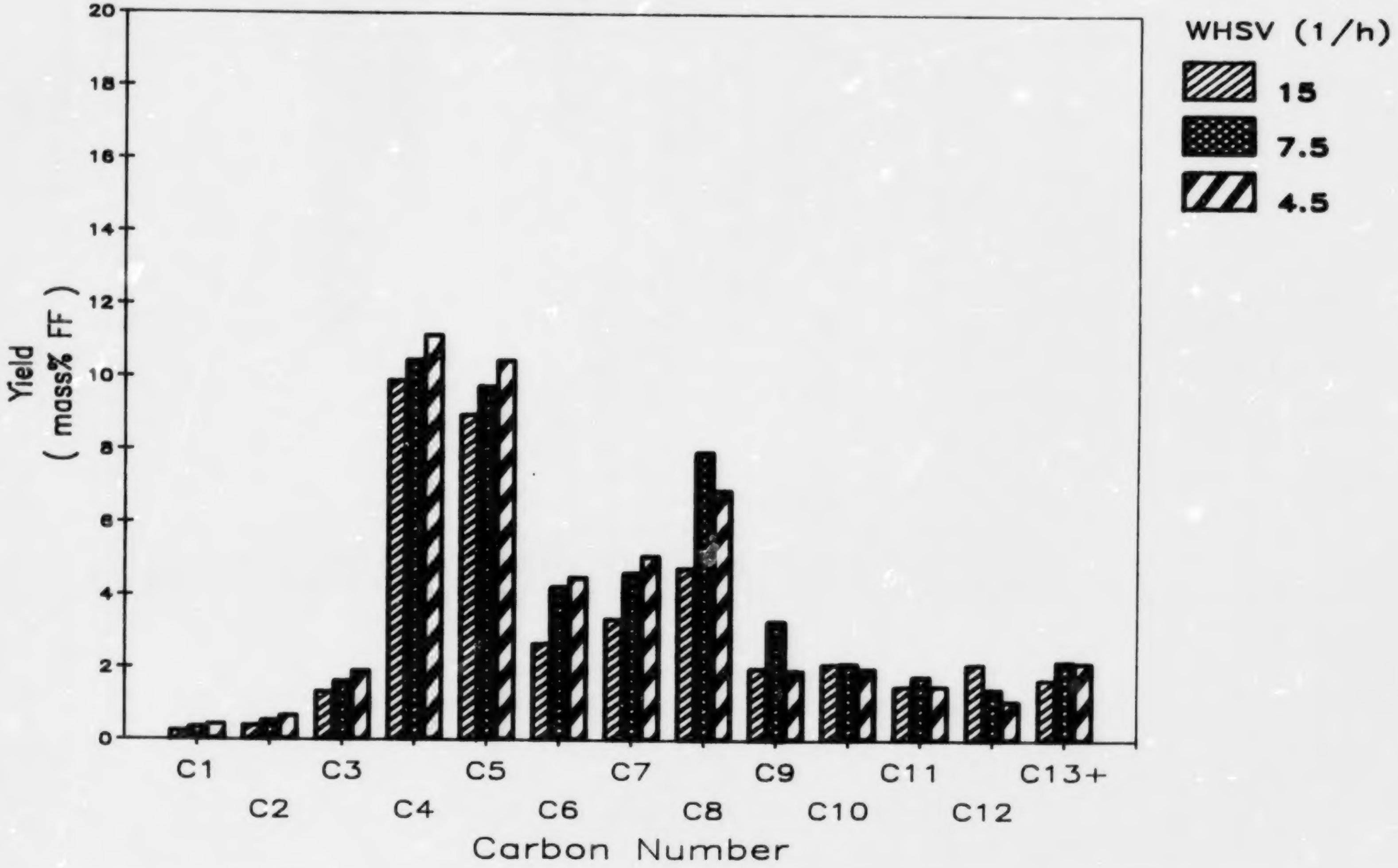
Blend A



T4ACD

Task 4. Key Component Blends & Synergistic Effects

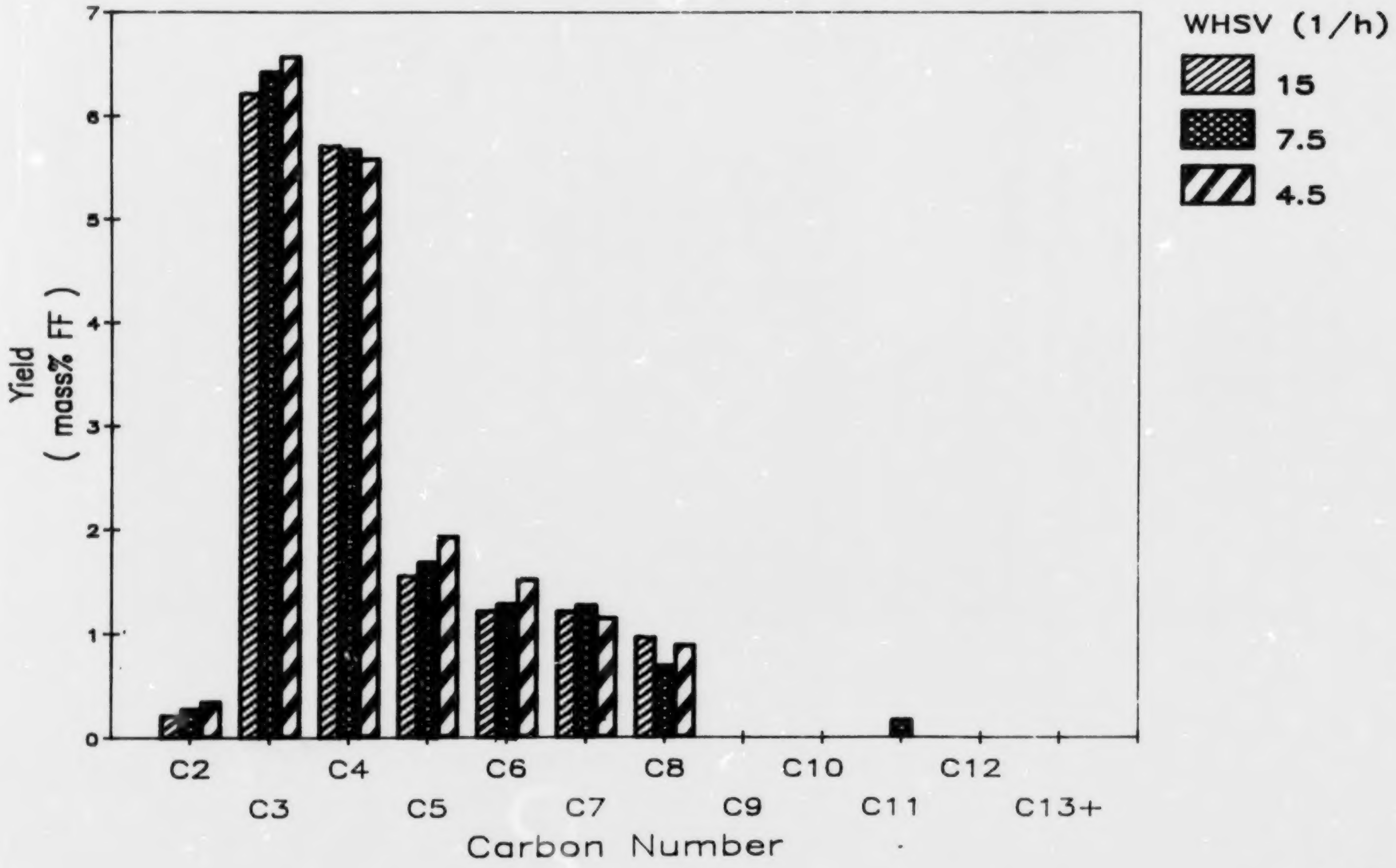
PARAFFIN DISTRIBUTION
Blend A



Task 4. Key Component Blends & Synergistic Effects

OLEFIN DISTRIBUTION

Blend A

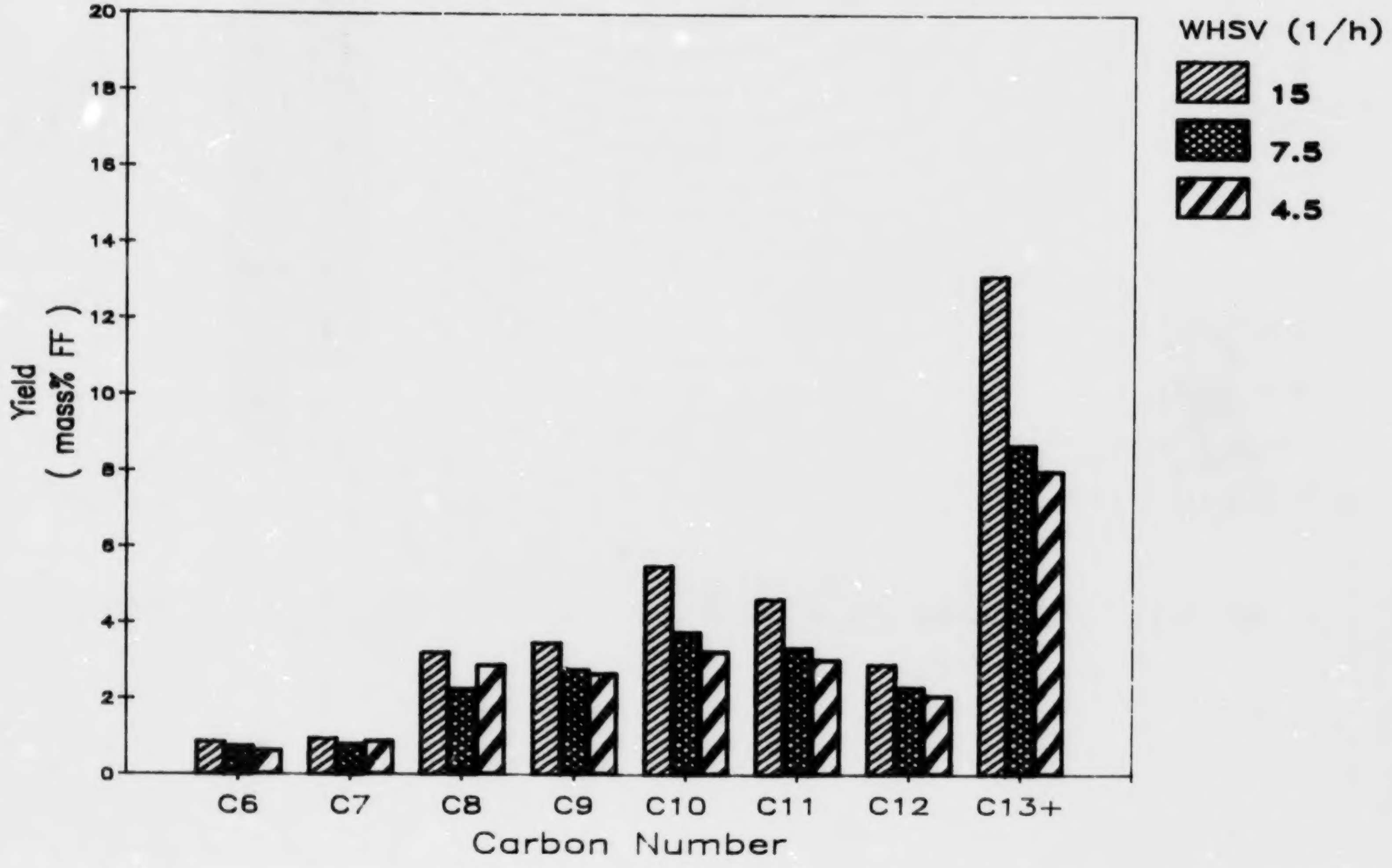


T40A

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION

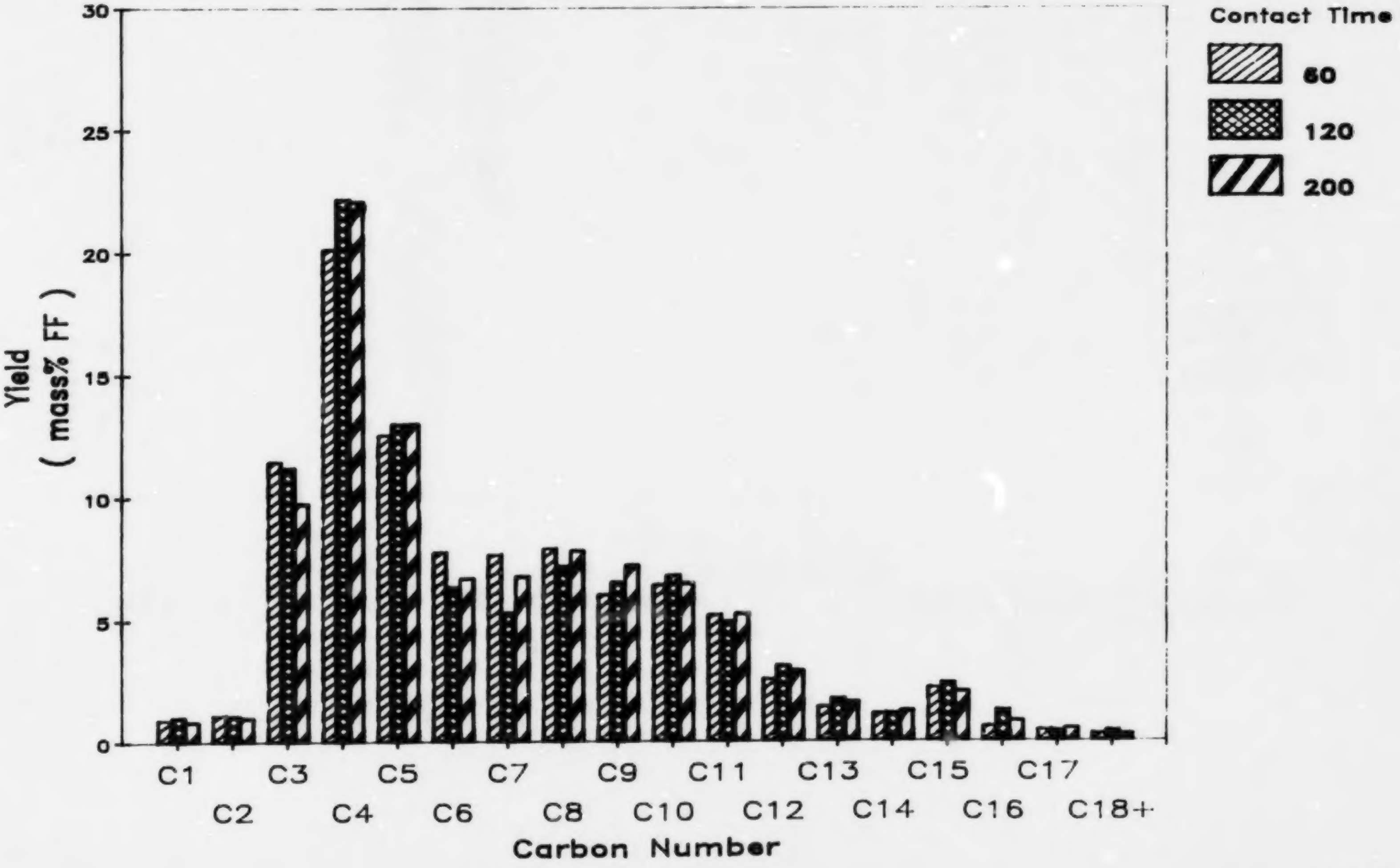
Blend A



T4AA

Task 4. Key Component Blends & Synergistic Effects

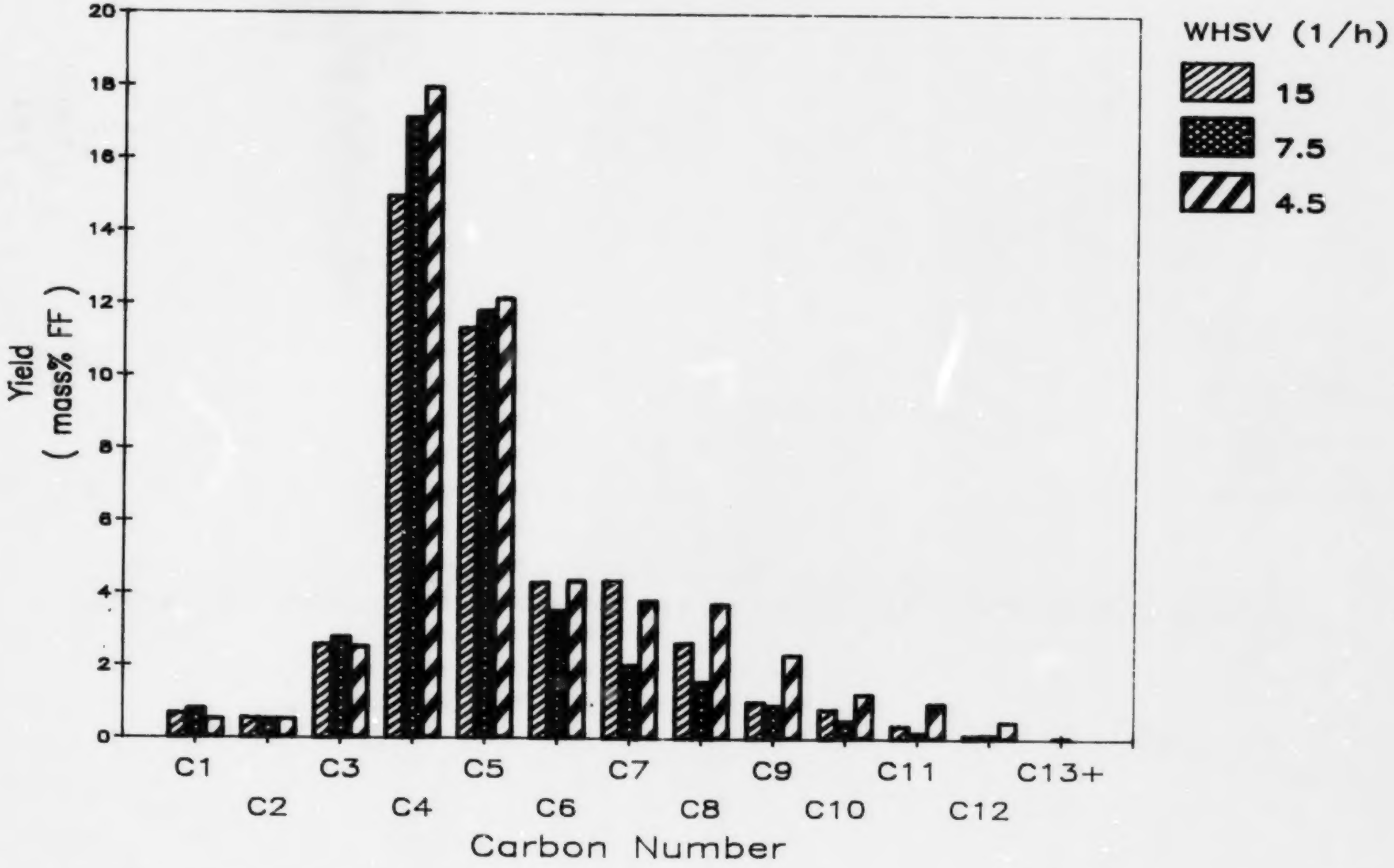
REACTOR EFFLUENT CARBON DISTRIBUTION
Blend B



T4BCD

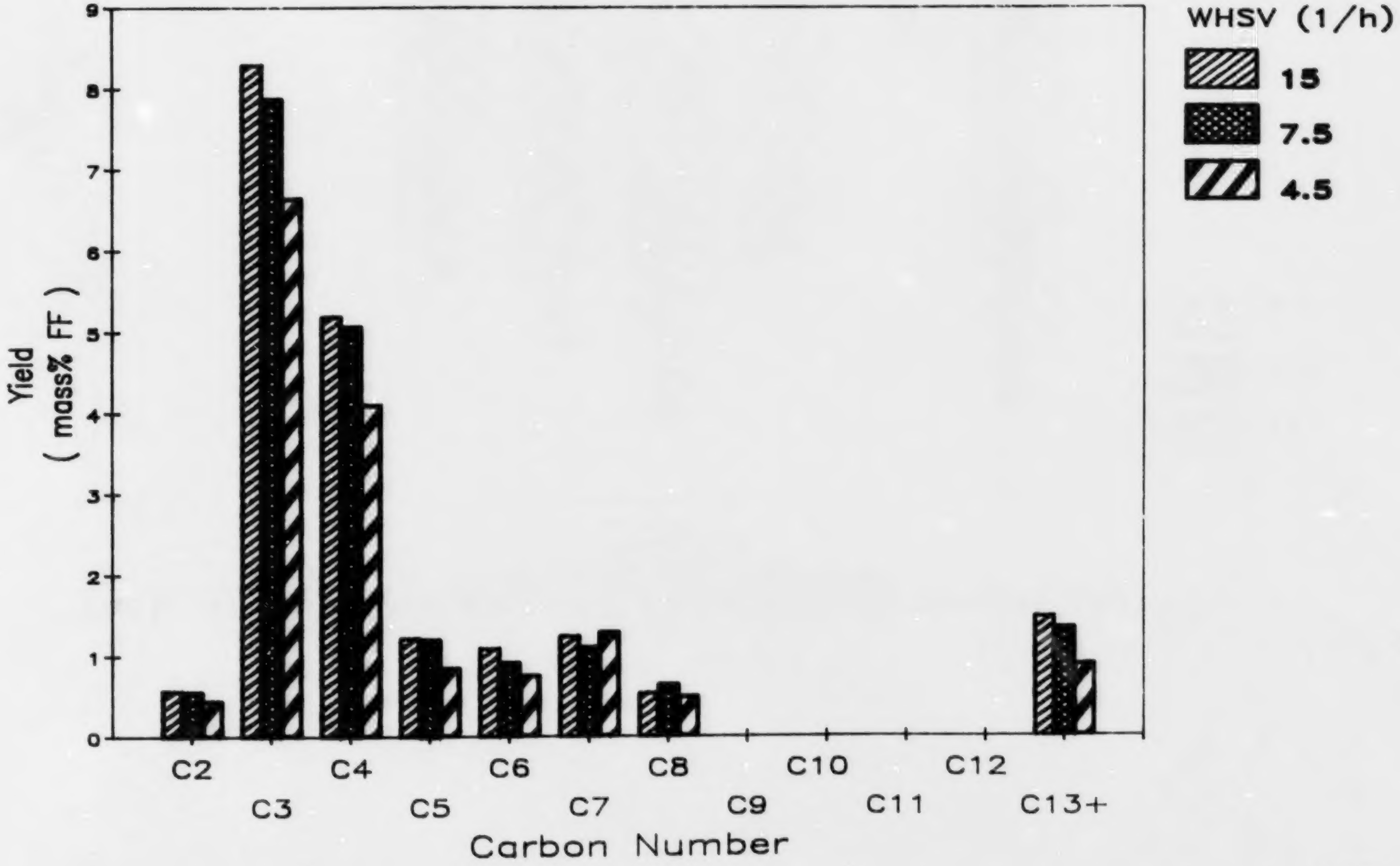
Task 4. Key Component Blends & Synergistic Effects

PARAFFIN DISTRIBUTION
Blend B



Task 4. Key Component Blends & Synergistic Effects

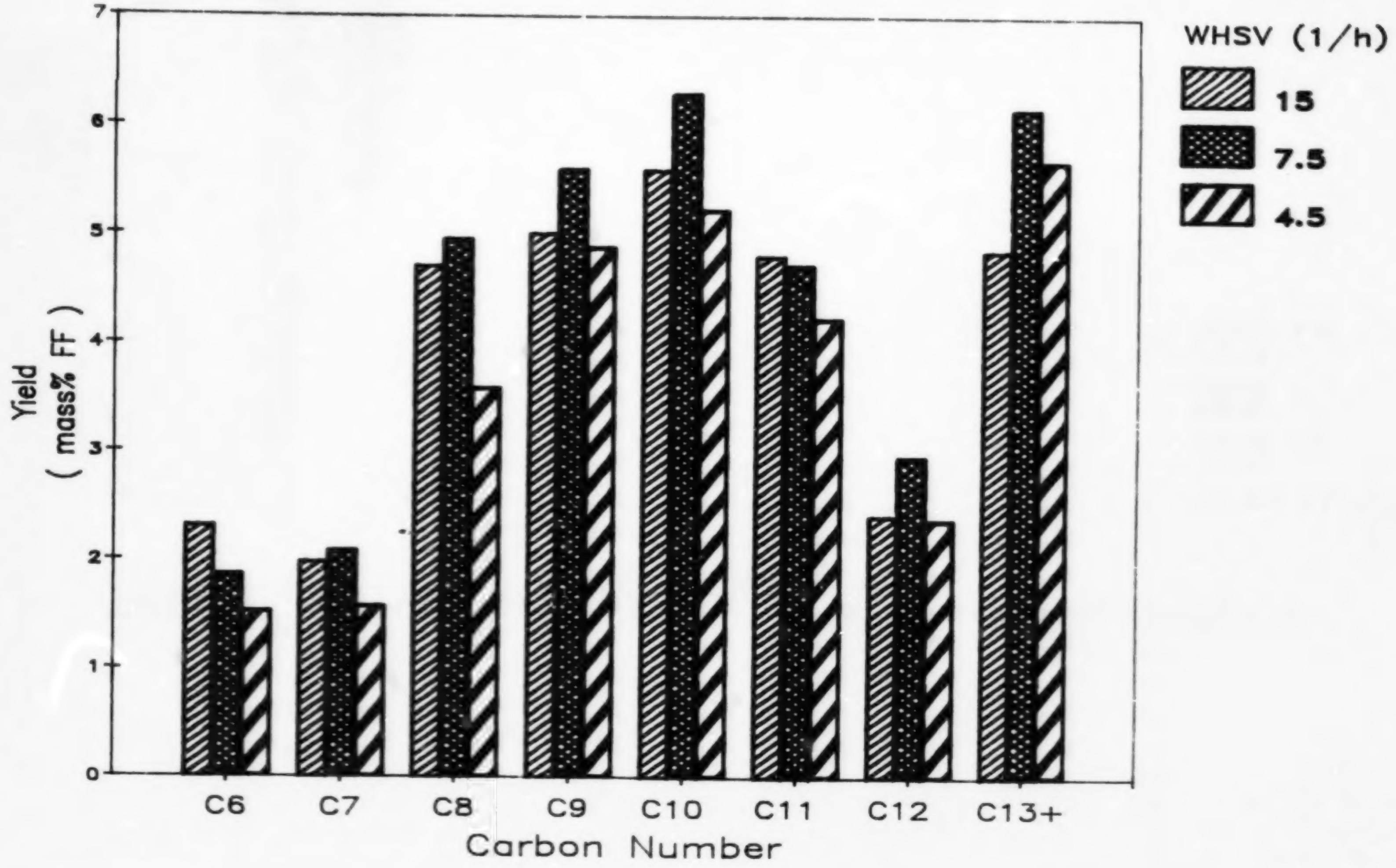
OLEFIN DISTRIBUTION
Blend B



T40B

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION
Blend B

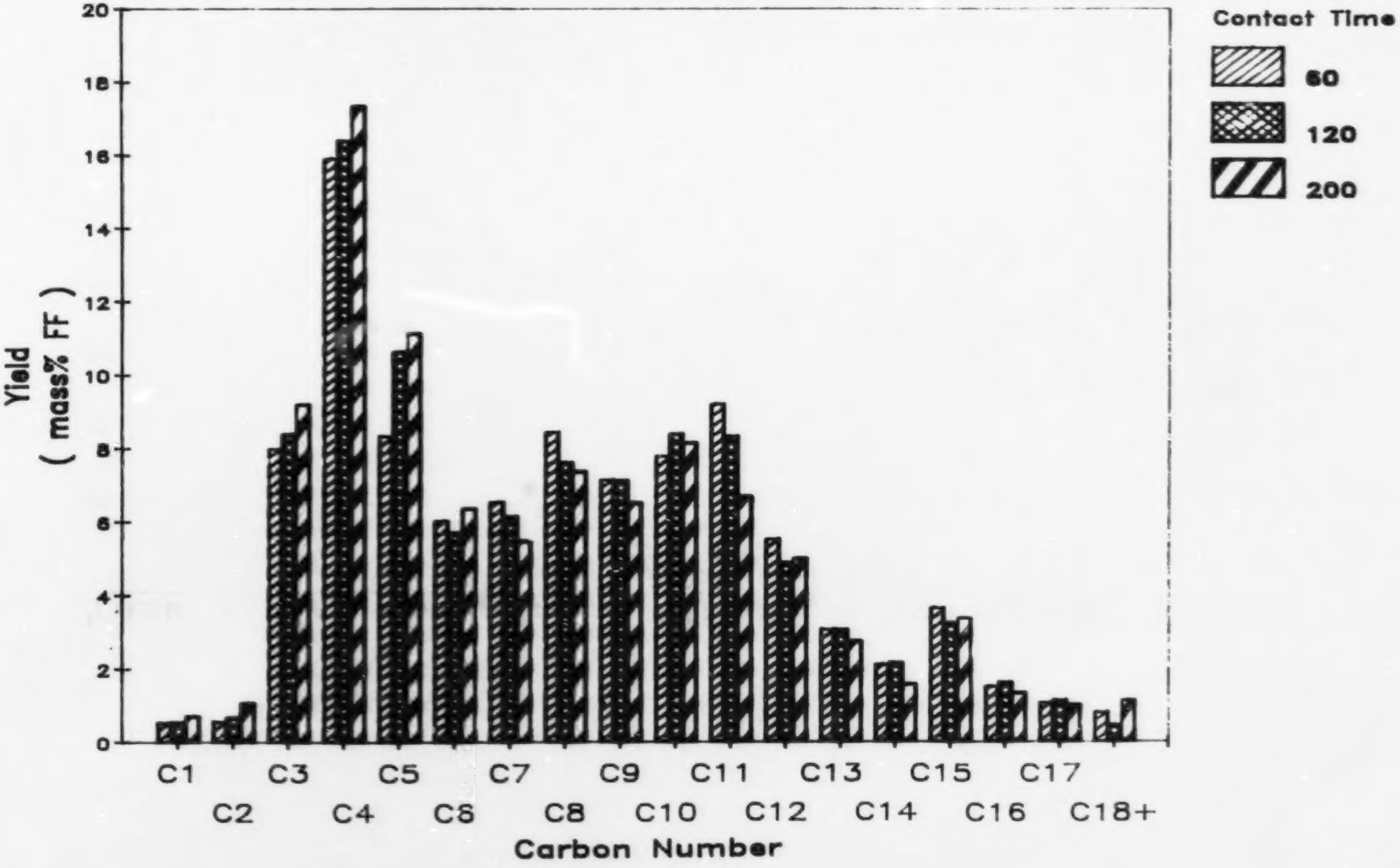


T4AB

Task 4. Key Component Blends & Synergistic Effects

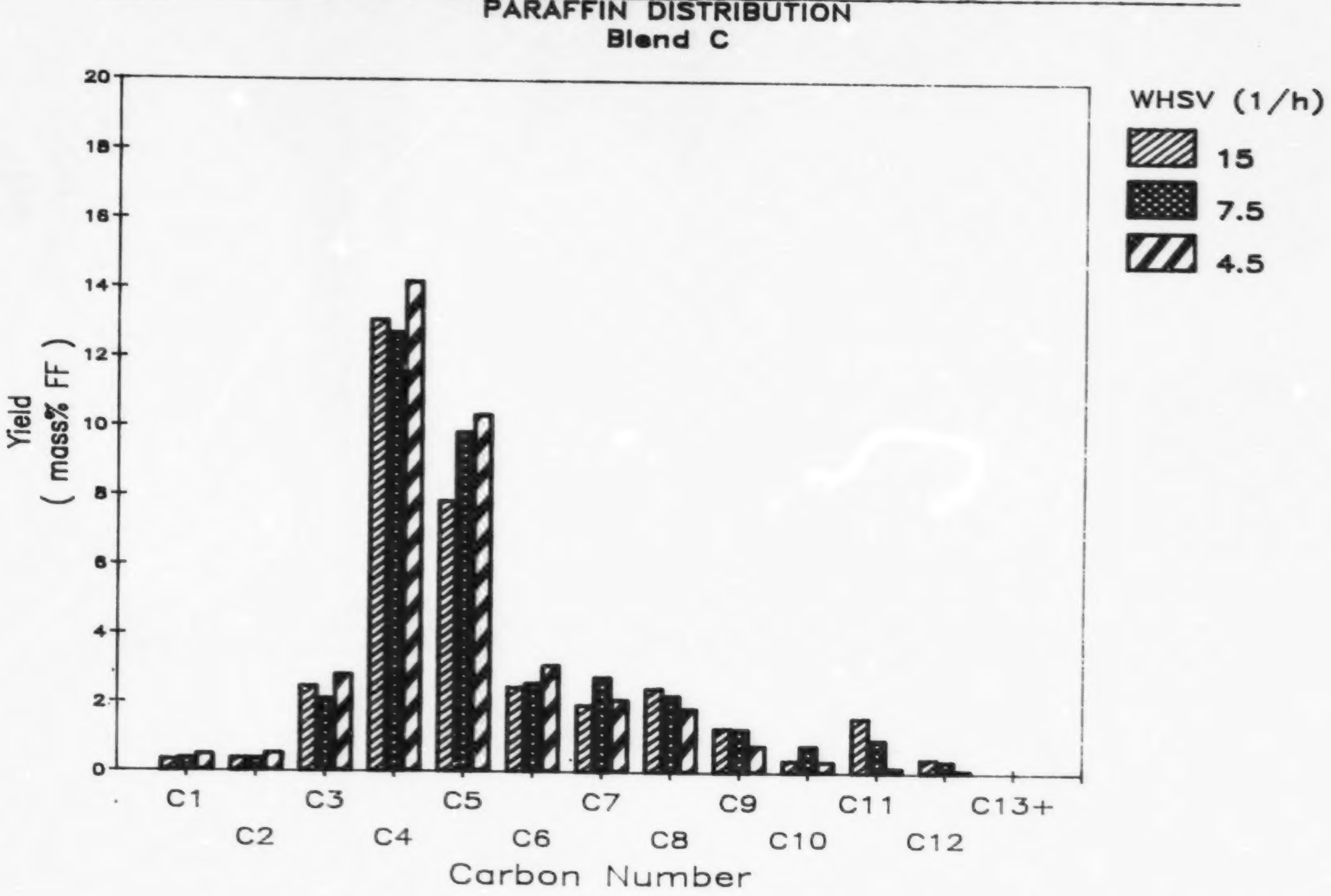
REACTOR EFFLUENT CARBON DISTRIBUTION

Blend C



T-4CCD

Task 4. Key Component Blends & Synergistic Effects

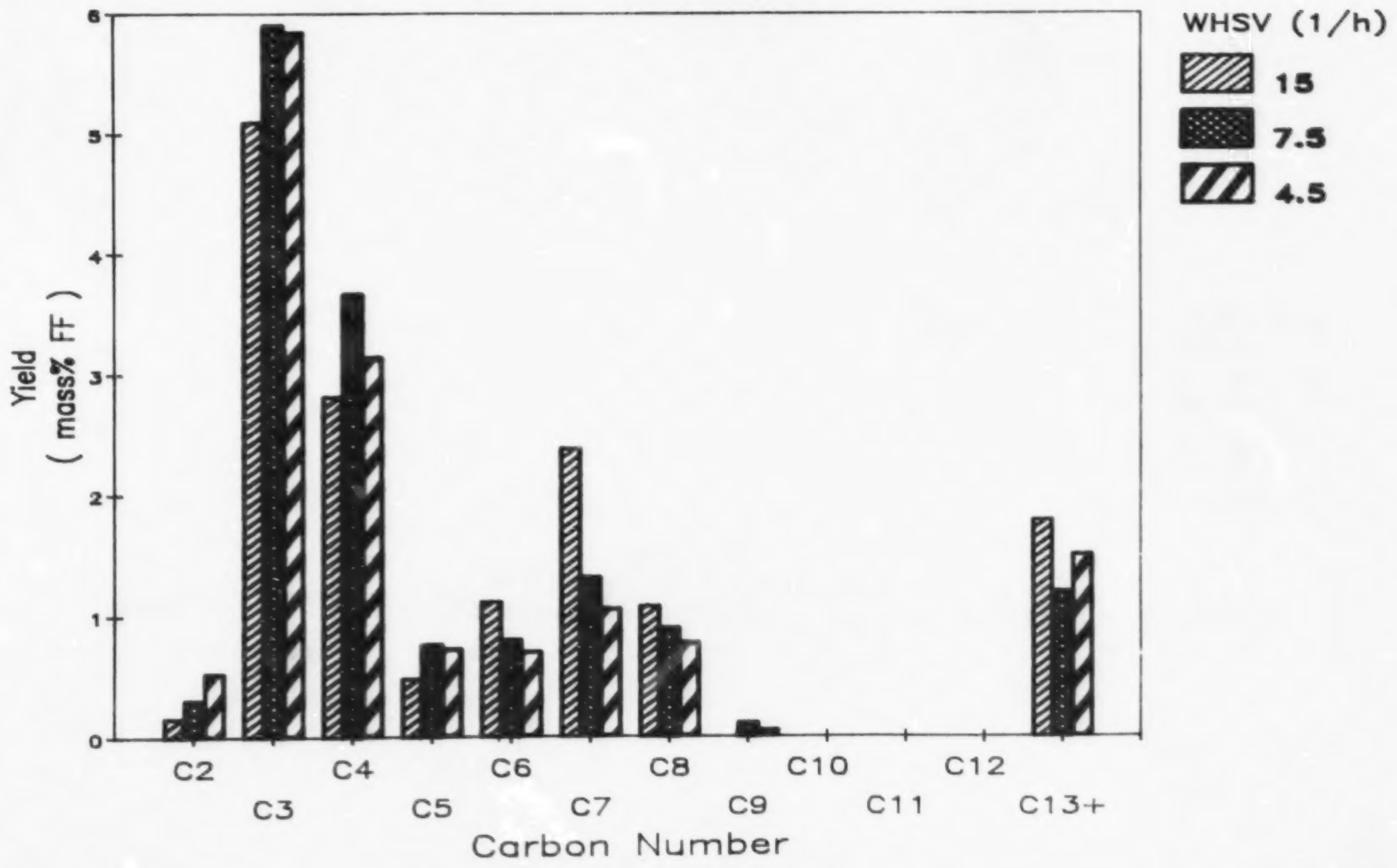


T4PC

Task 4. Key Component Blends & Synergistic Effects

OLEFIN DISTRIBUTION

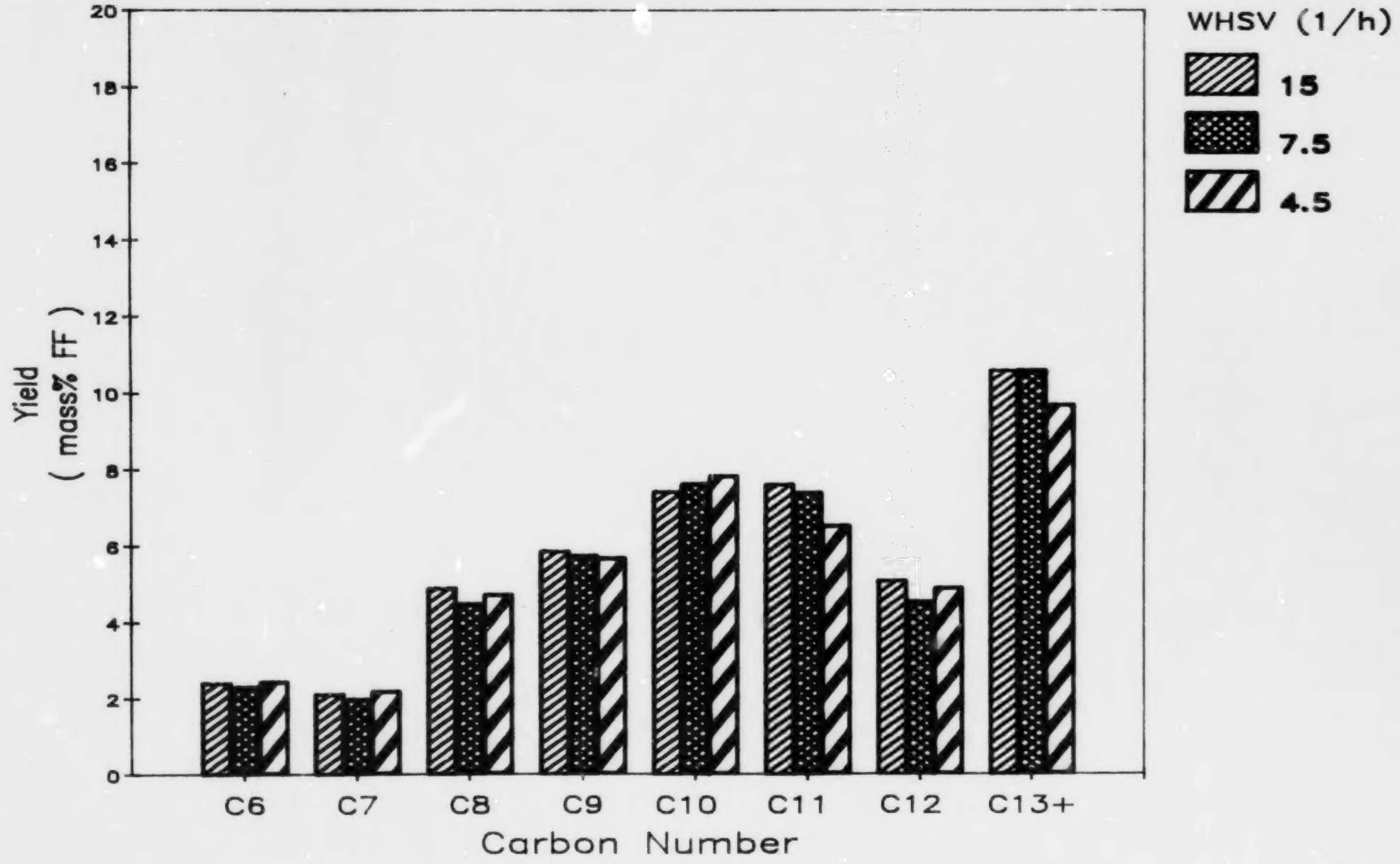
Blend C



T40C

Task 4. Key Component Blends & Synergistic Effects

AROMATIC DISTRIBUTION
Blend C

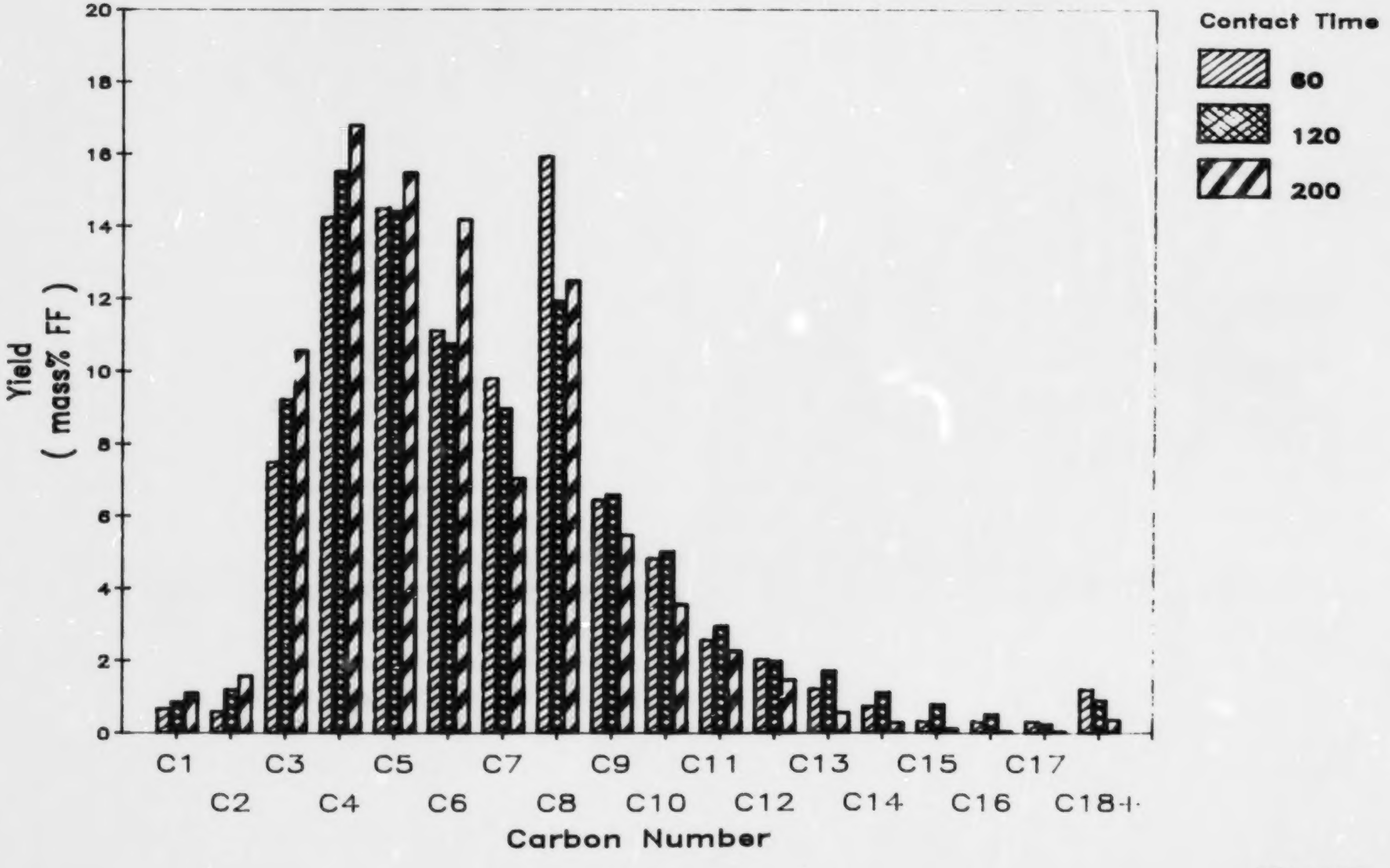


T4AC

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

Feed : Blend A   Catalyst : 0.11% CRC

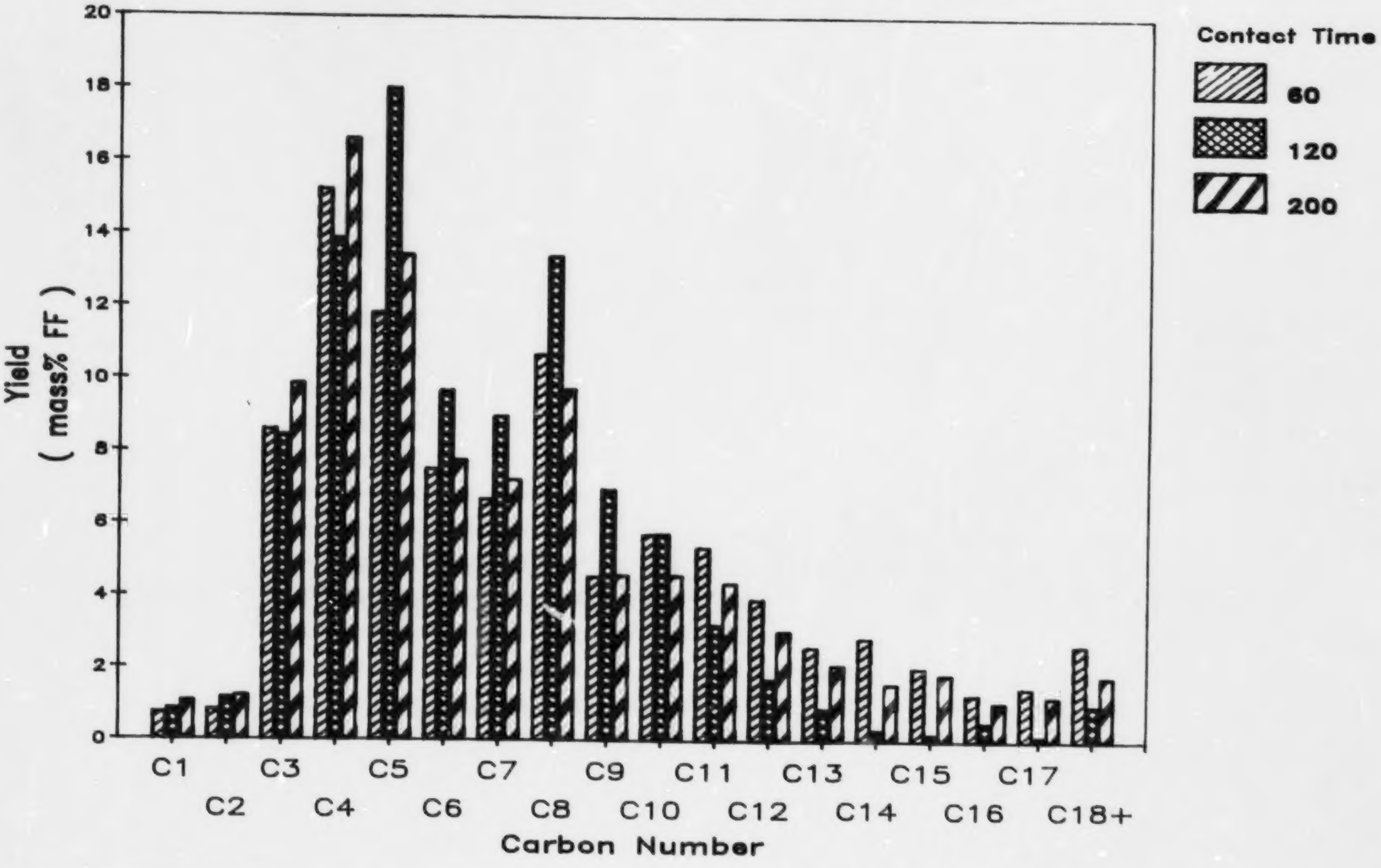


T5A11CD

Task 5. Residual Catalyst Coke on Cracking Yields

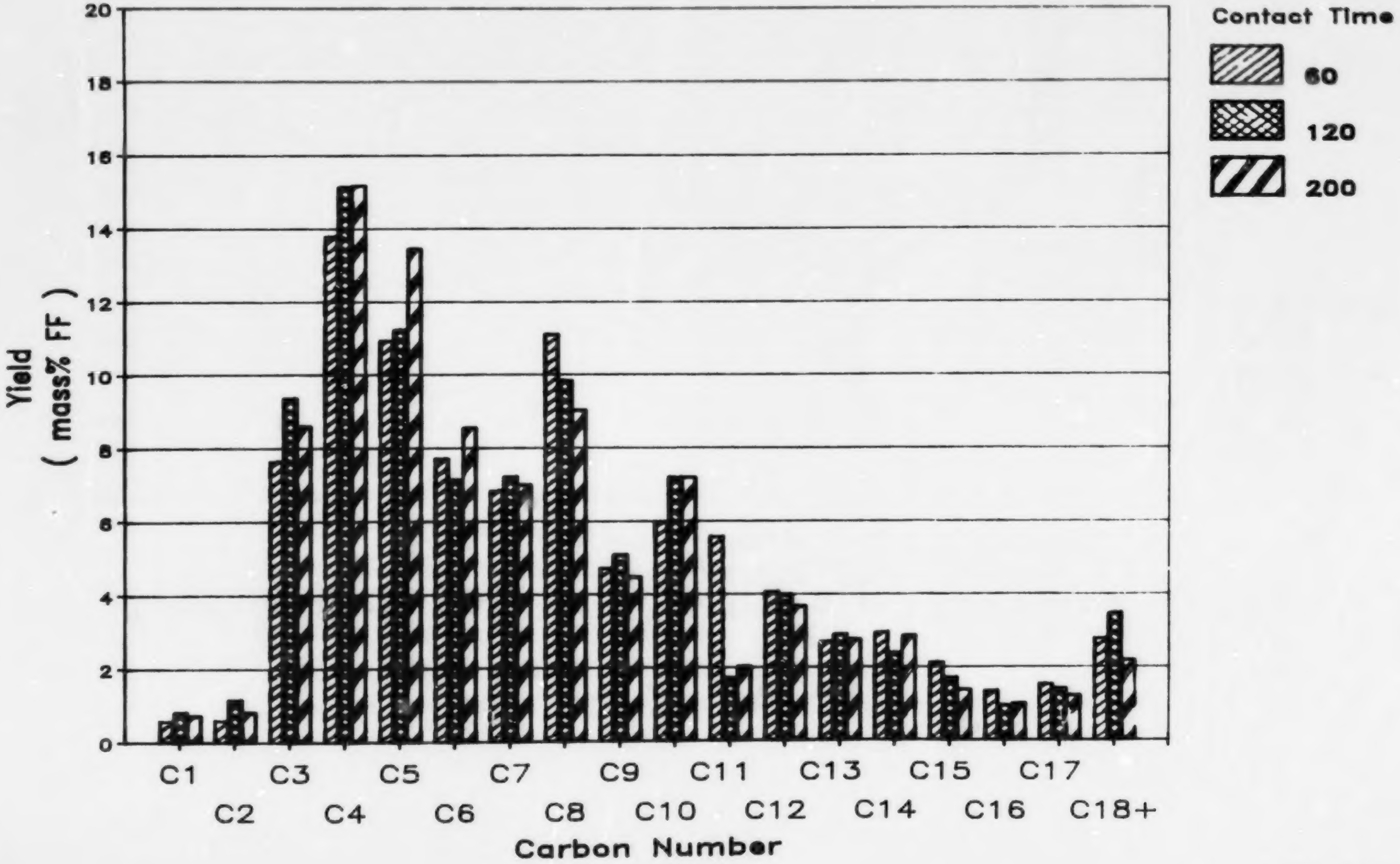
REACTOR EFFLUENT CARBON DISTRIBUTION

Feed : Blend A   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend A   Catalyst : 0.48% CRC

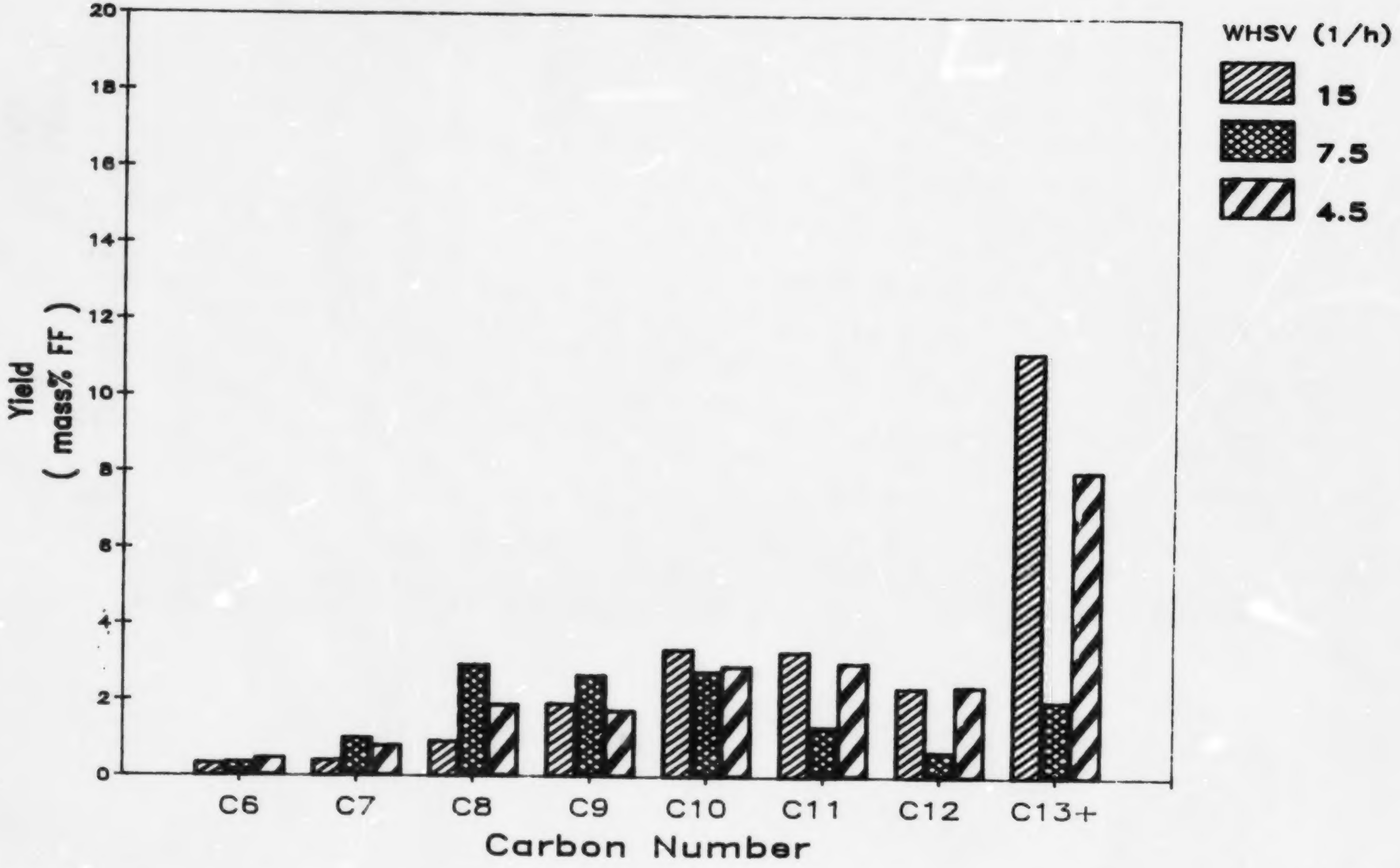


T5A48CD

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

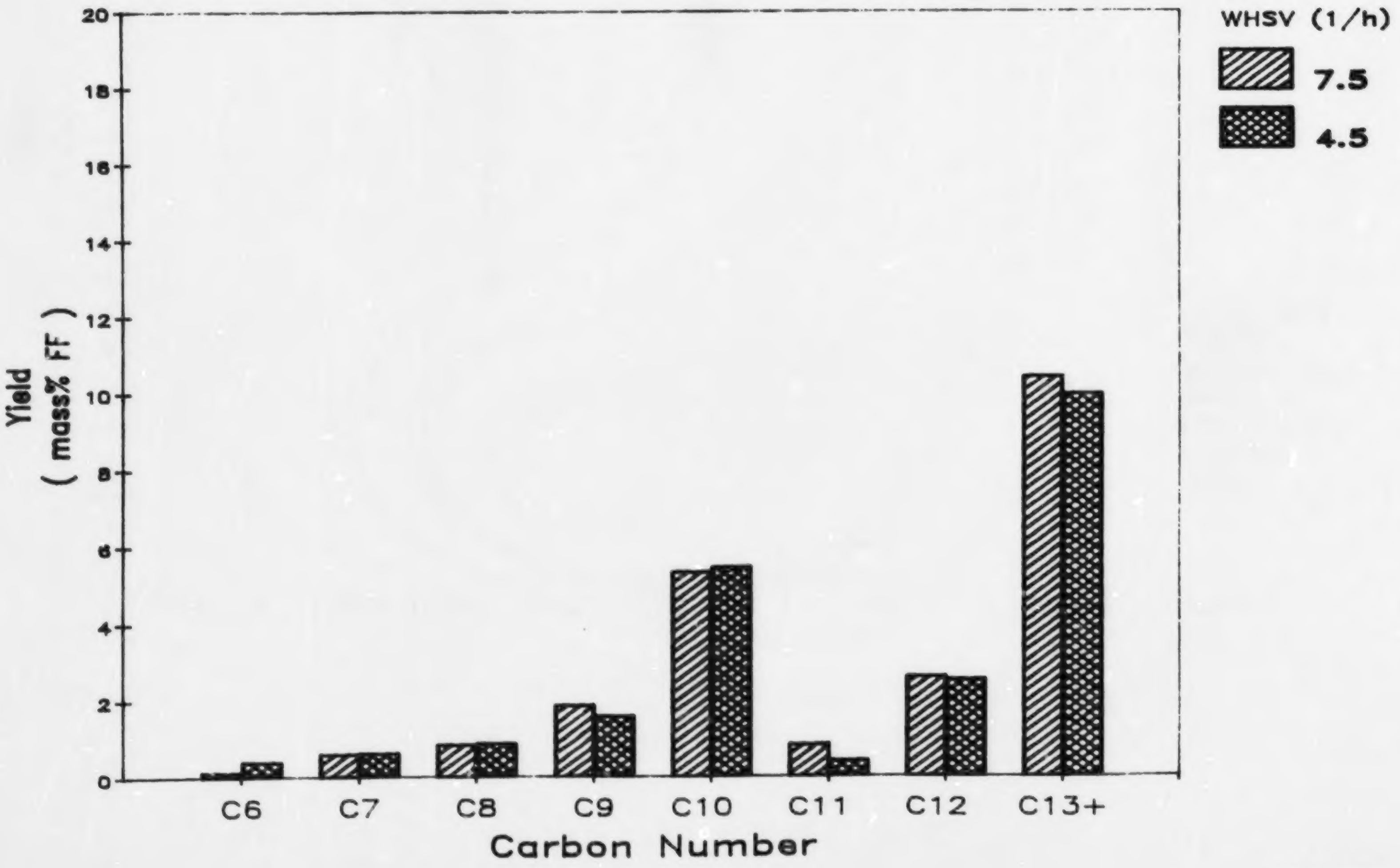
Feed : Blend A   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

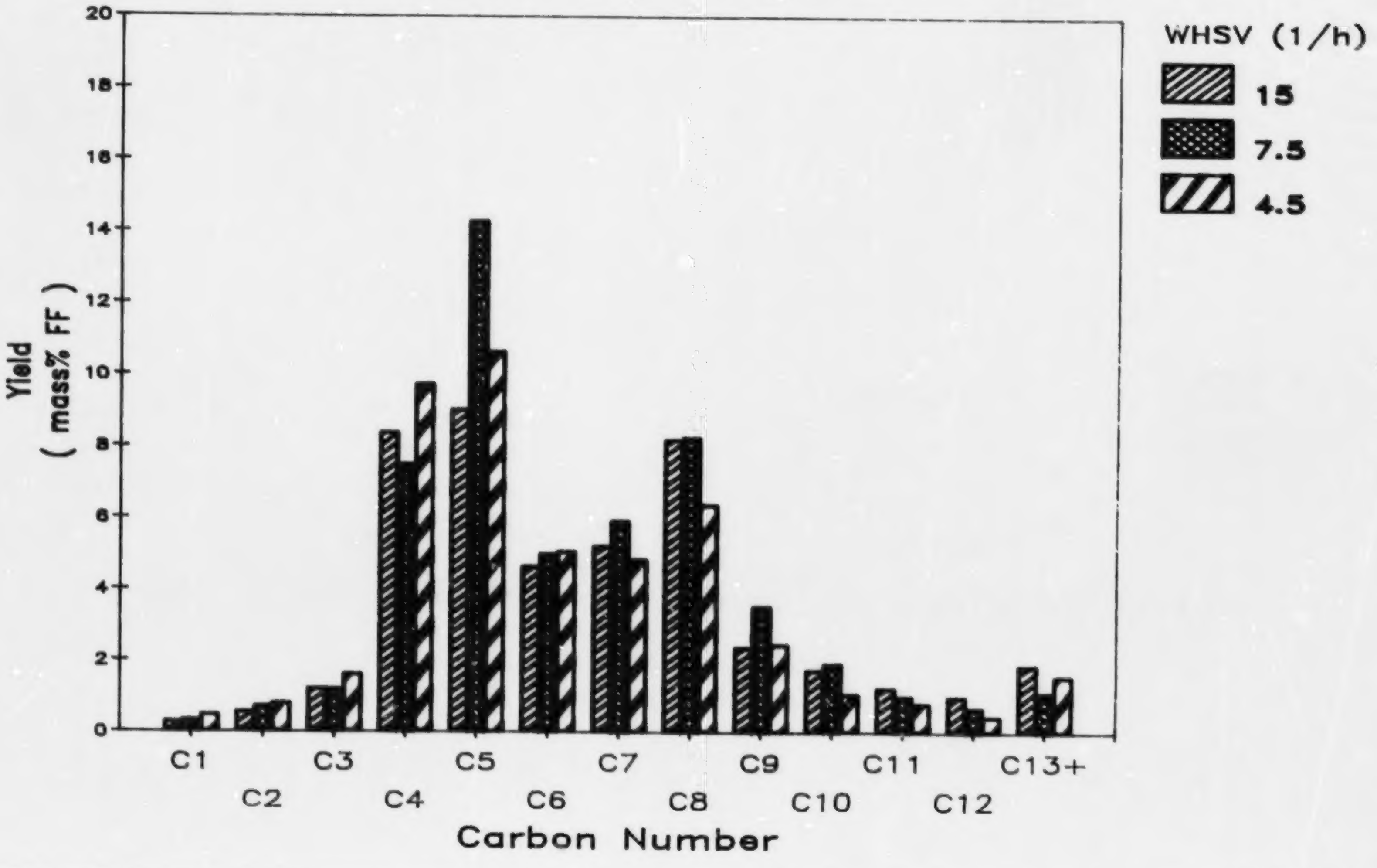
Feed : Blend A   Catalyst : 0.48% CRC



T5AA27C

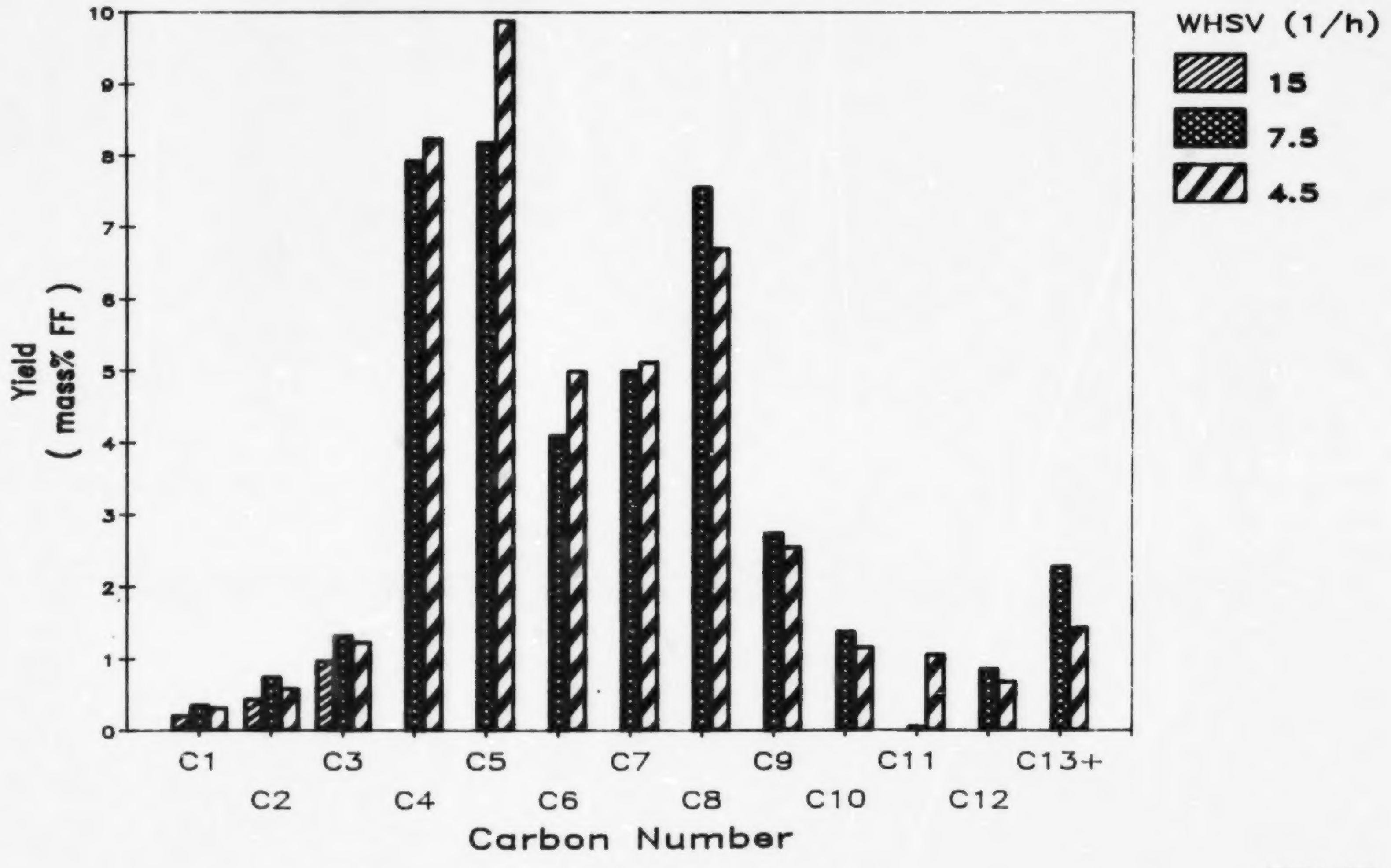
Task 5. Residual Catalyst Coke on Cracking Yields

PARAFFIN DISTRIBUTION
Blend A -- 0.27% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

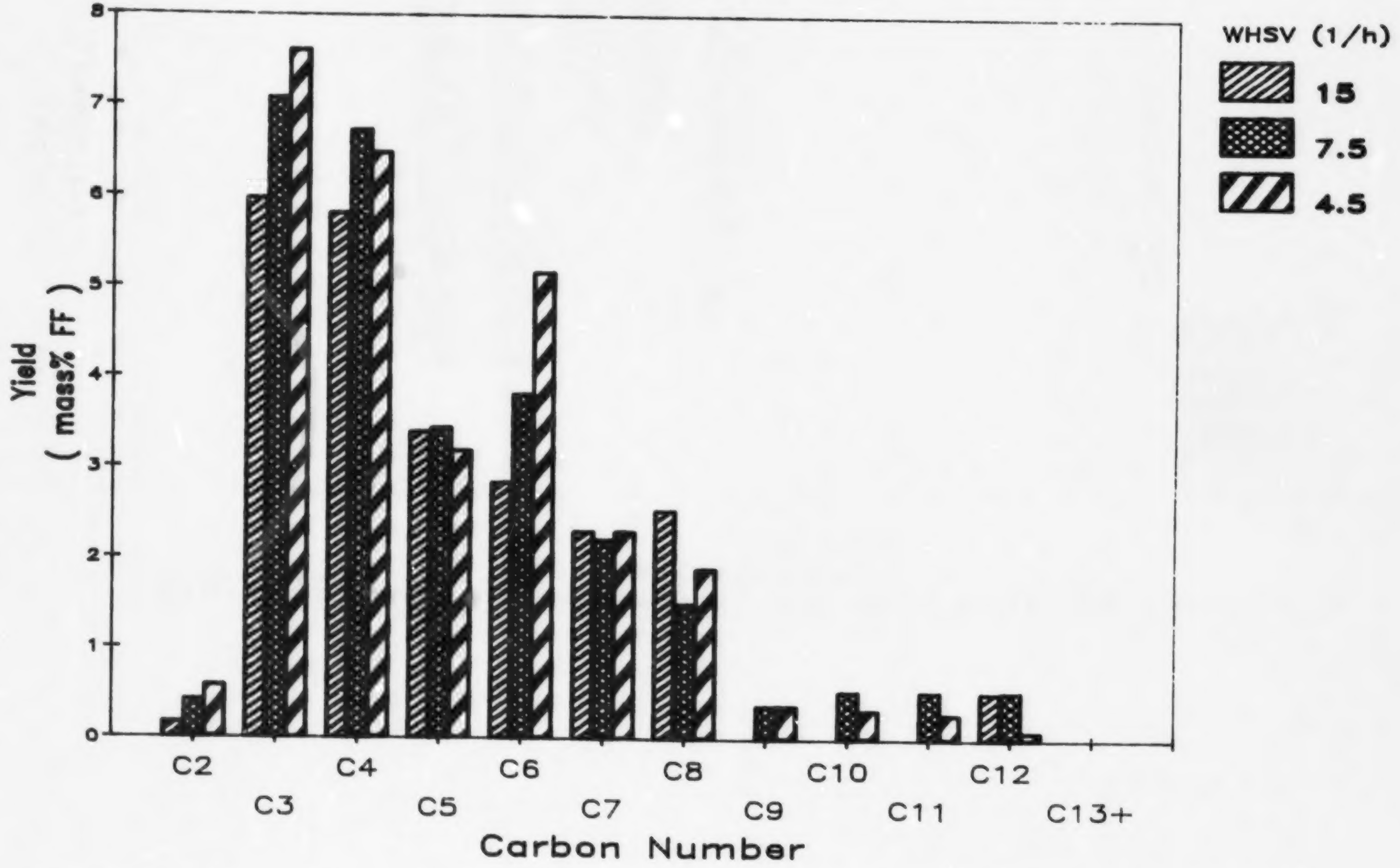
PARAFFIN DISTRIBUTION
Blend A -- 0.48% Coke



T5PA48C

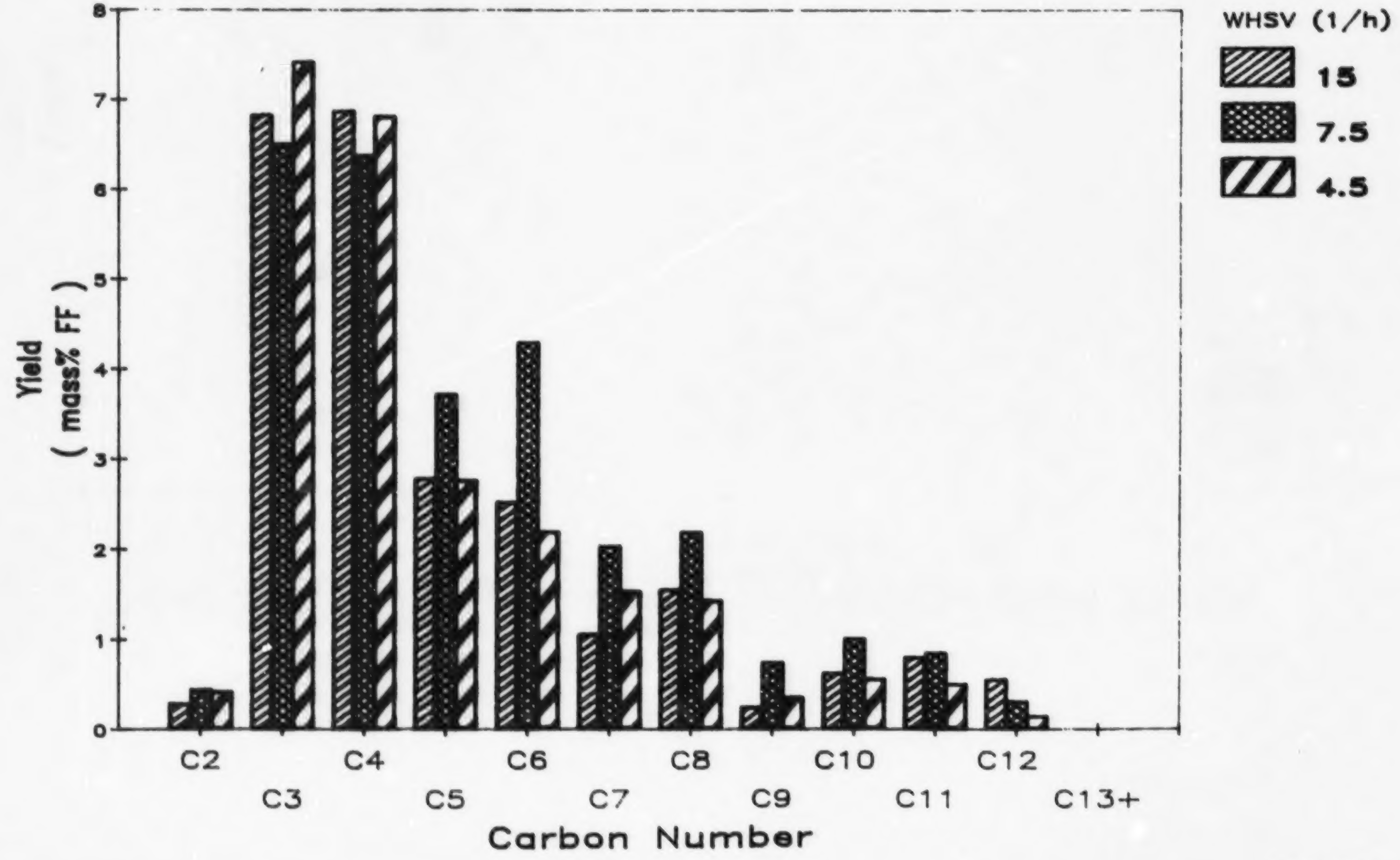
Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend A -- 0.11% Coke



T5OA11C

Task 5. Residual Catalyst Coke on Cracking Yields

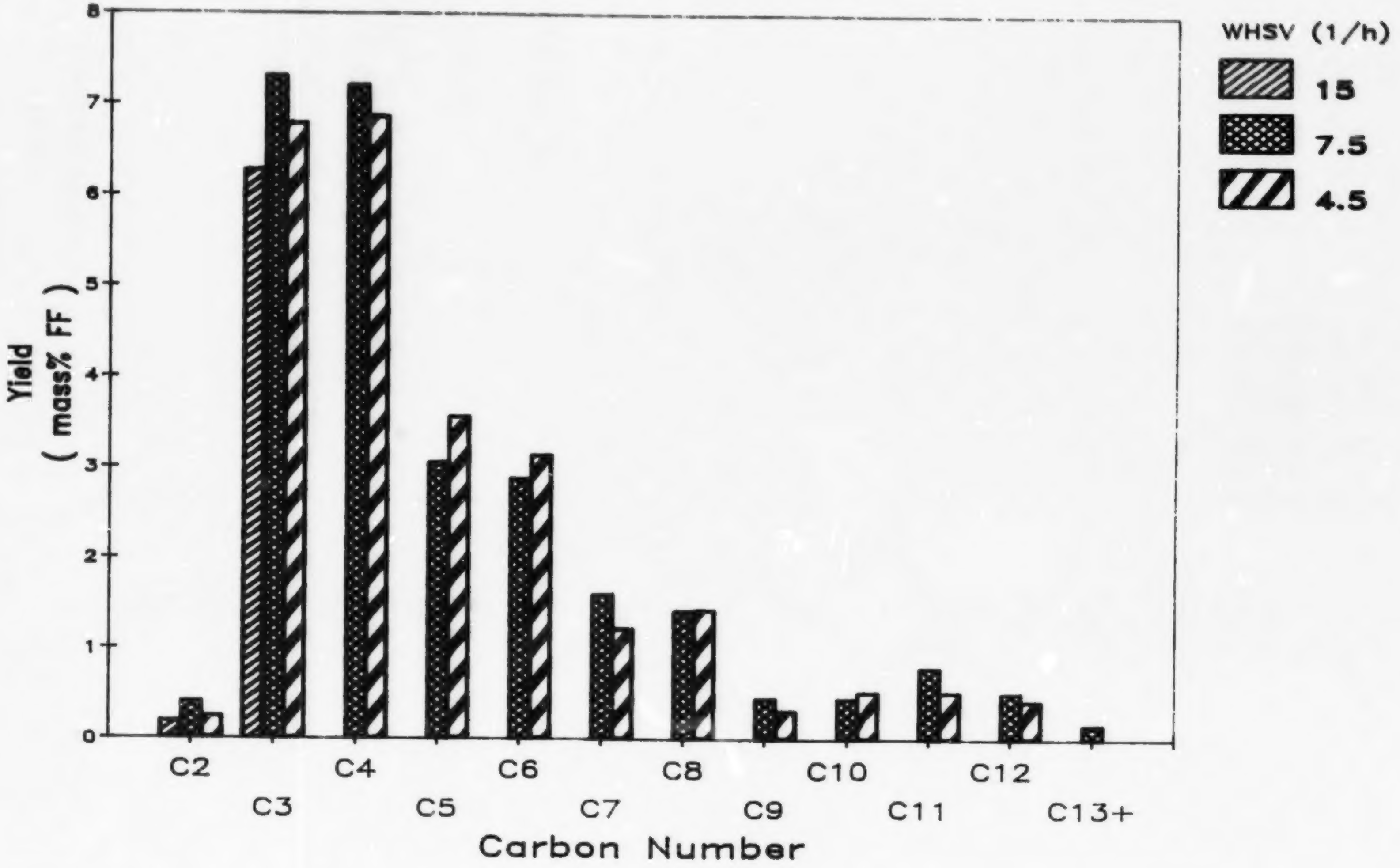


OLEFIN DISTRIBUTION
Blend A -- 0.27% Coke

T50A27C

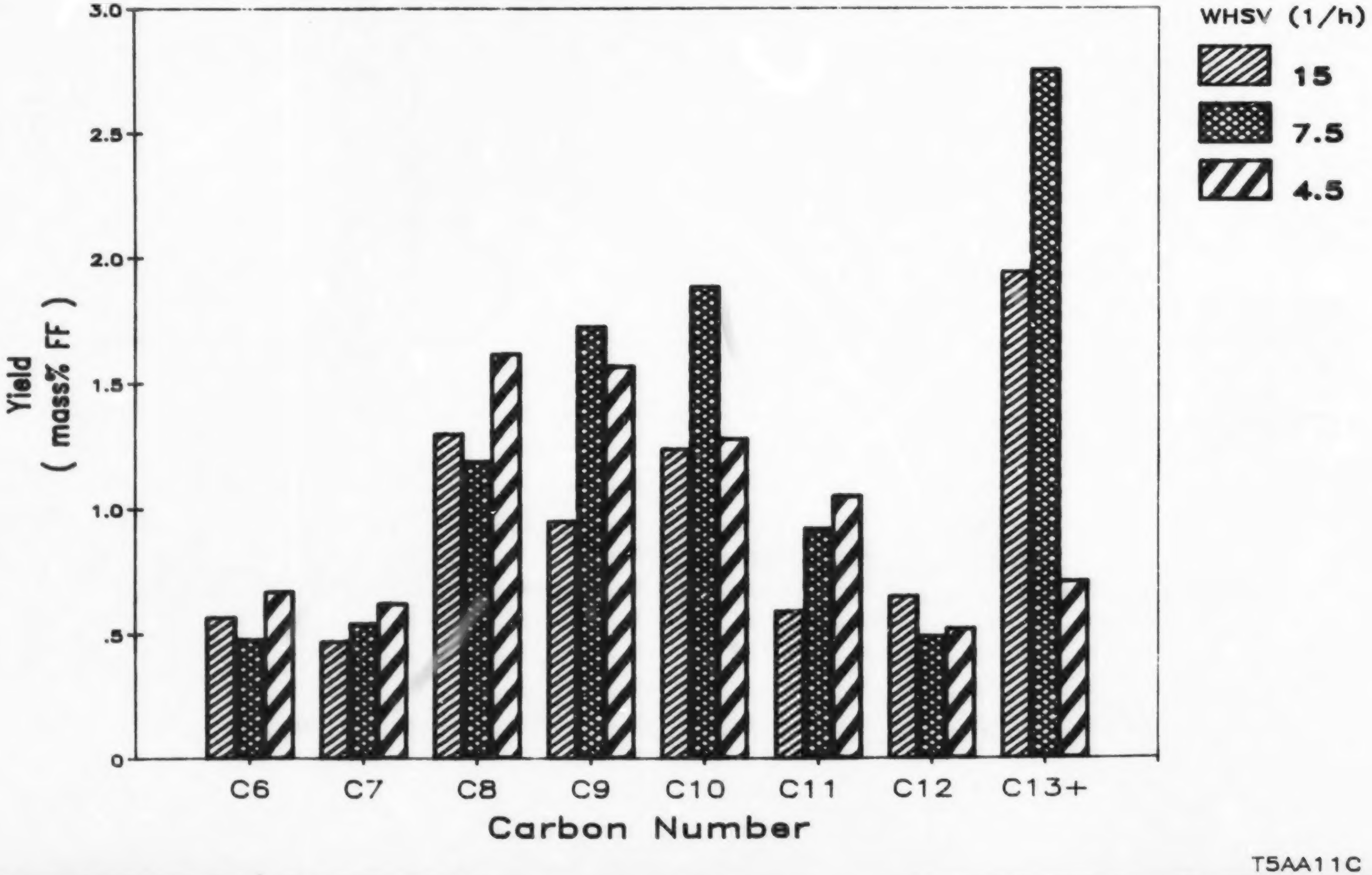
Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend A -- 0.48% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION
Blend A -- 0.11% Coke

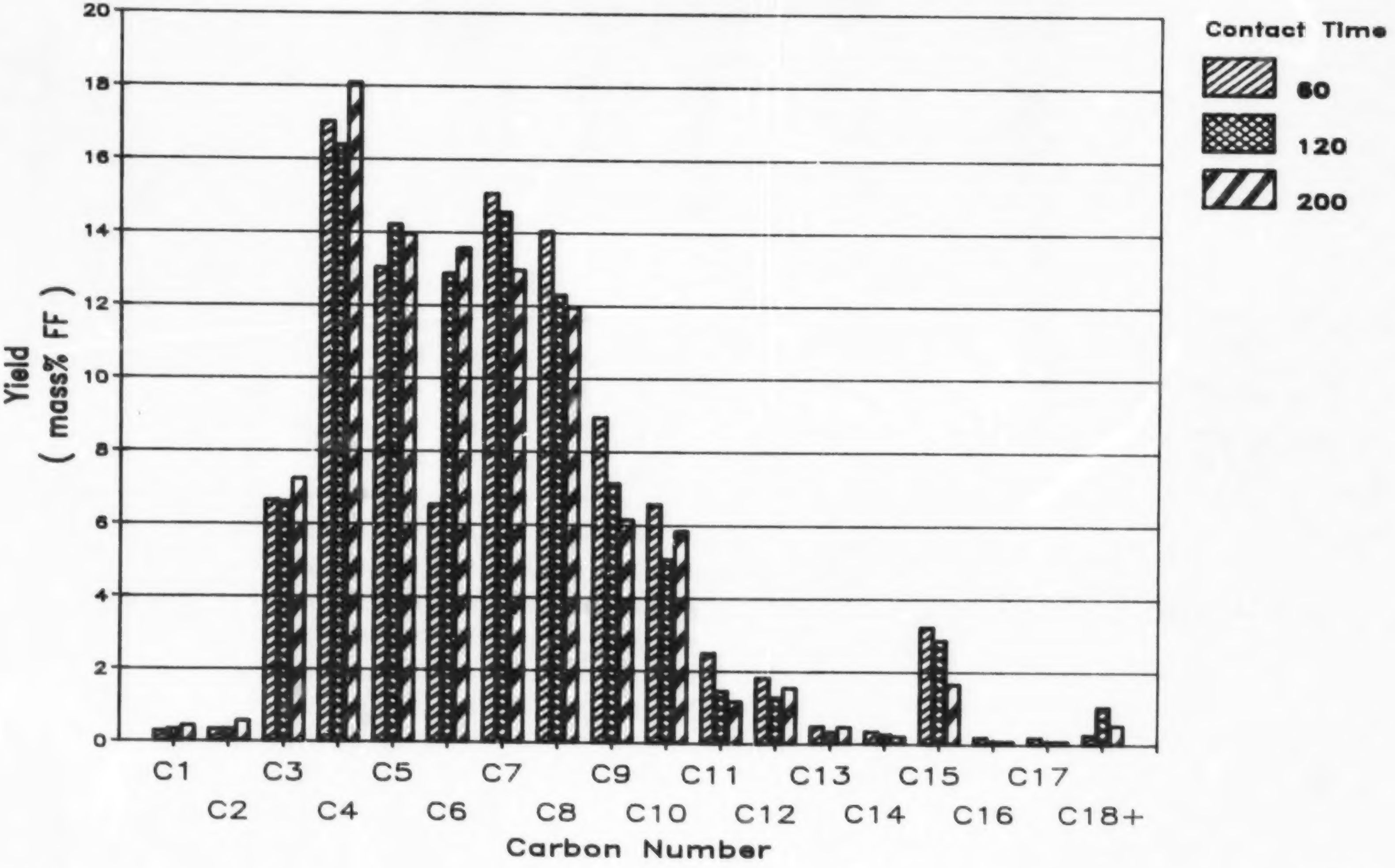


T5AA11C

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

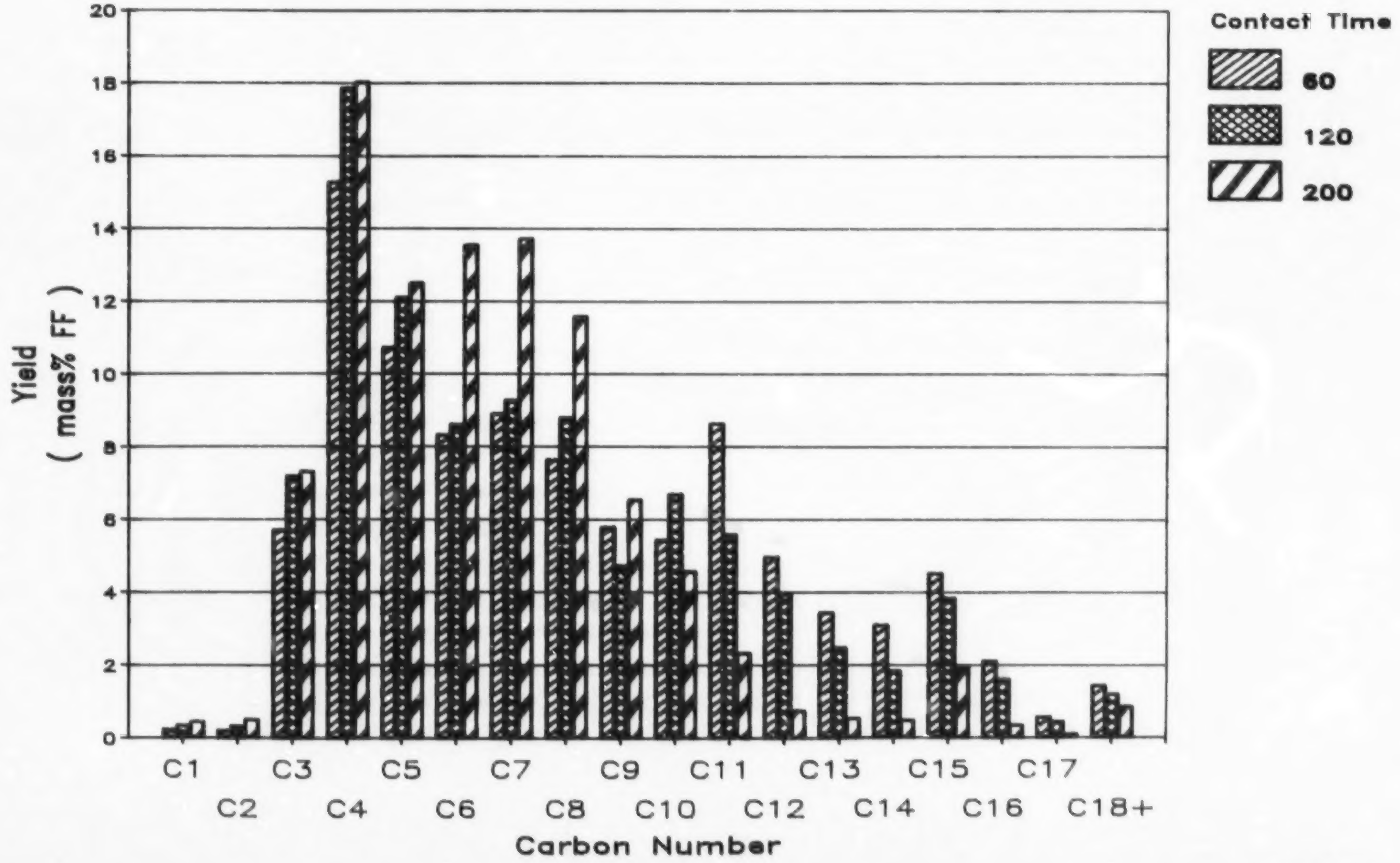
Feed : Blend B   Catalyst : 0.11% CRC



T5B11CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend B   Catalyst : 0.27% CRC

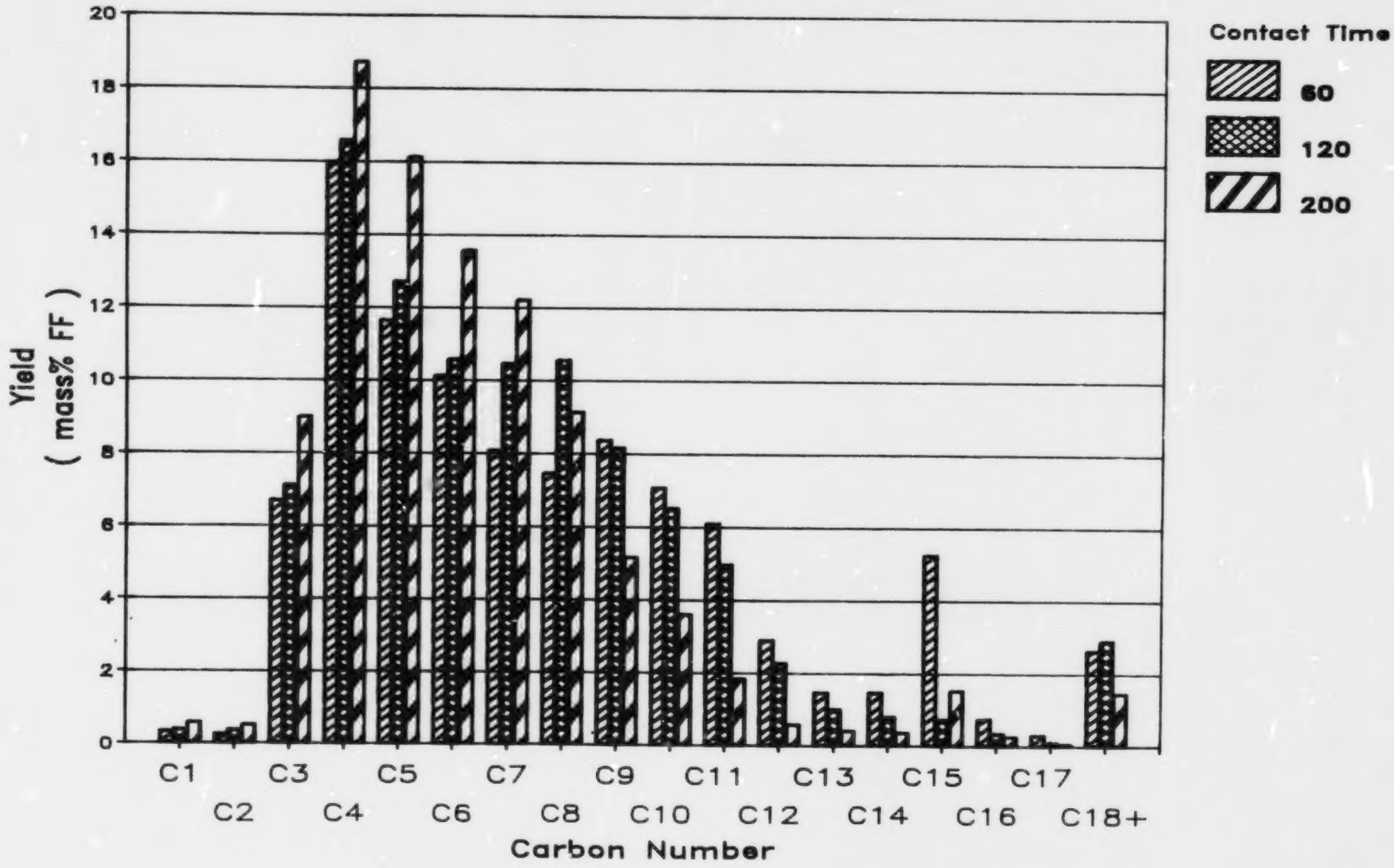


T5B27CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

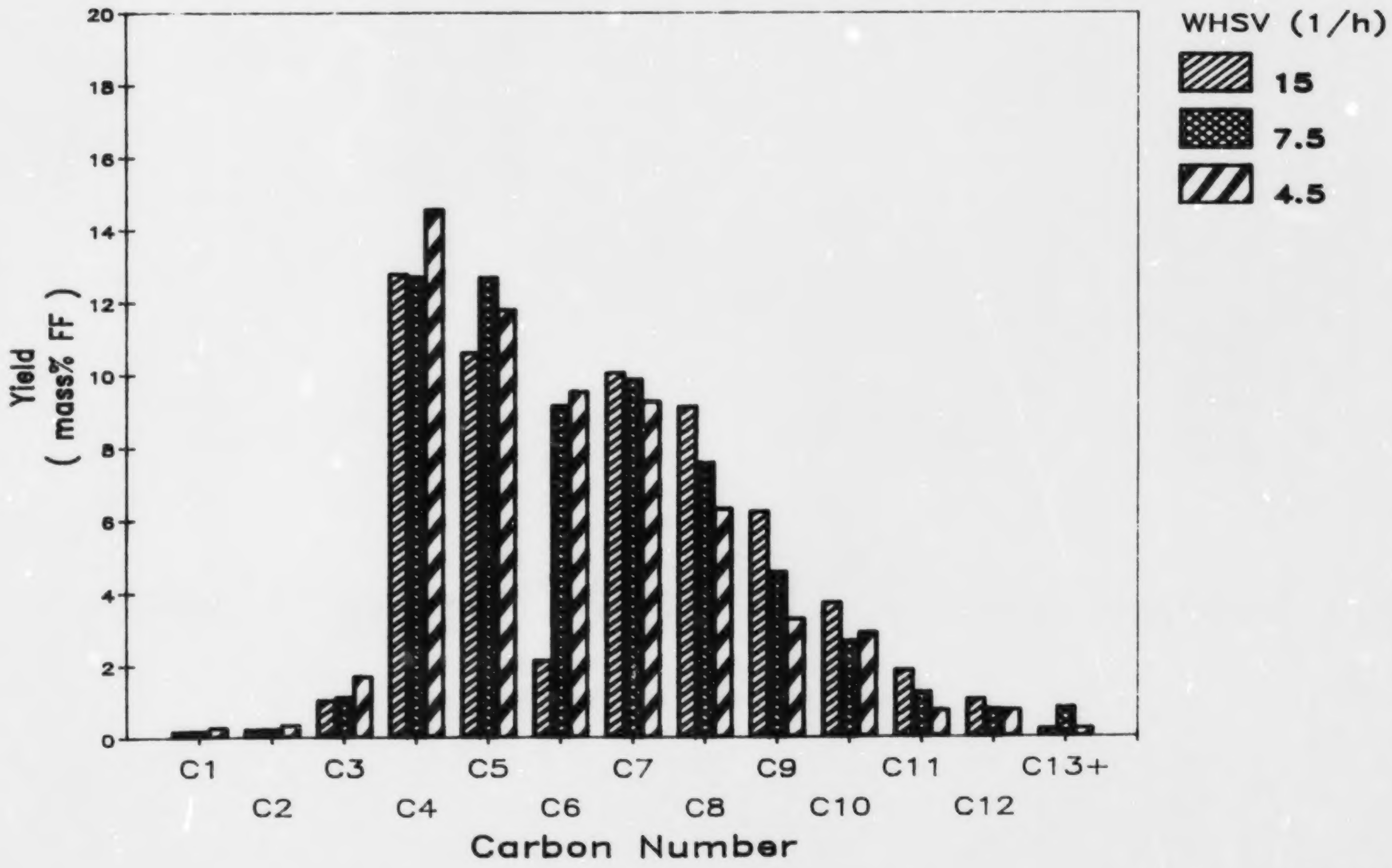
Feed : Blend B   Catalyst : 0.48% CRC



T5B48CD

Task 5. Residual Catalyst Coke on Cracking Yields

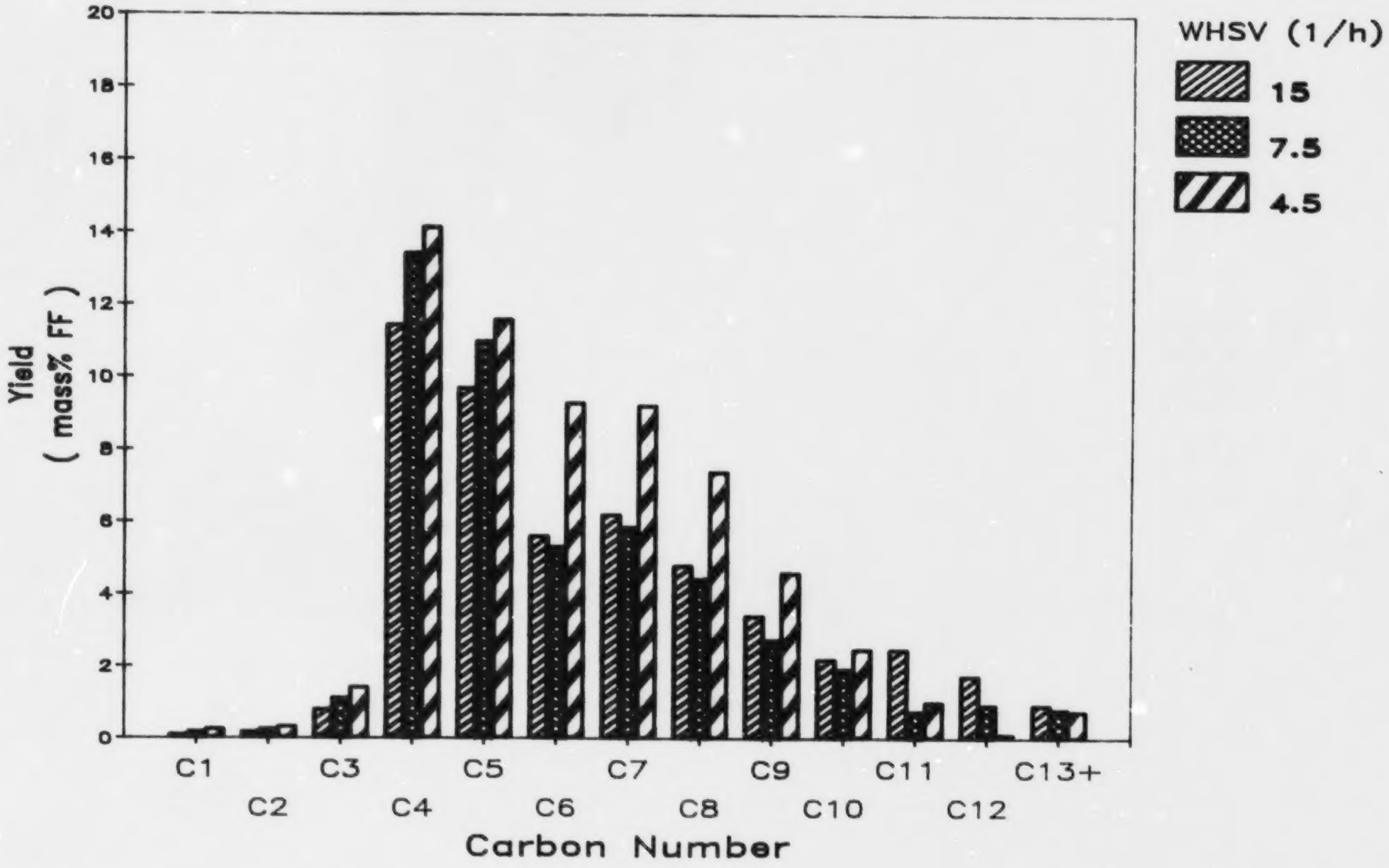
PARAFFIN DISTRIBUTION
Blend B -- 0.11% Coke



T5PB11C

Task 5. Residual Catalyst Coke on Cracking Yields

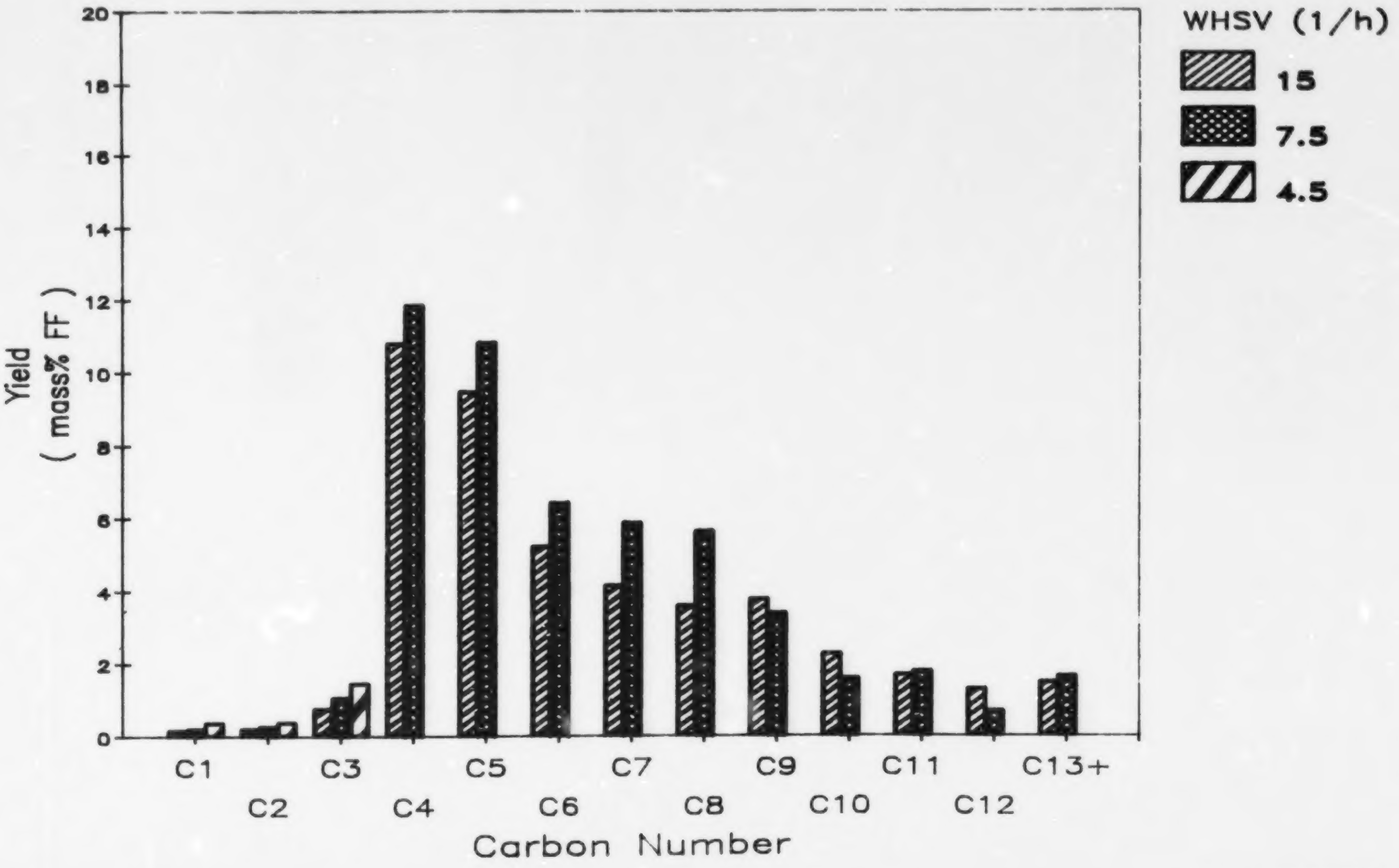
PARAFFIN DISTRIBUTION
Blend B -- 0.27% Coke



T5PB27C

Task 5. Residual Catalyst Coke on Cracking Yields

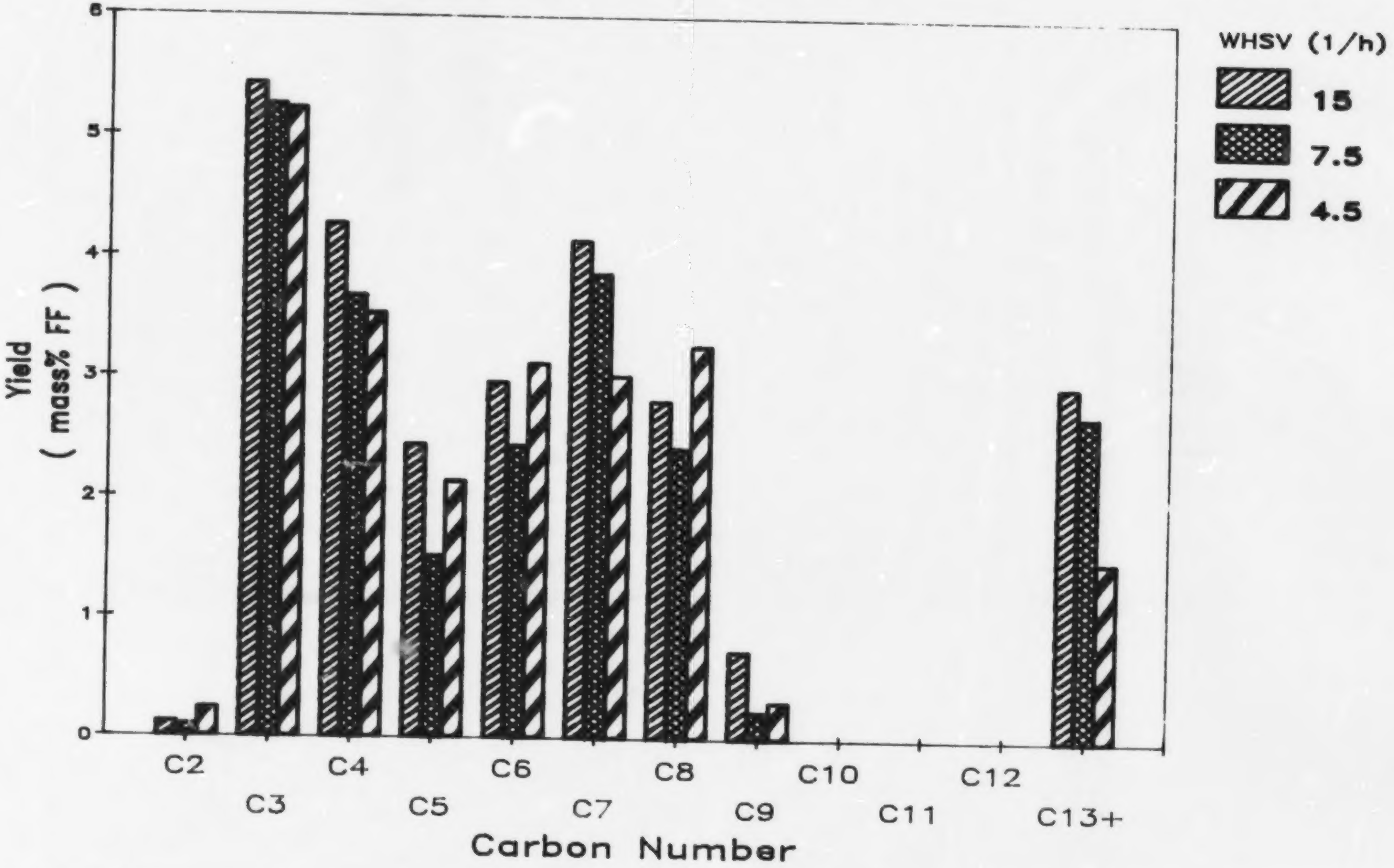
PARAFFIN DISTRIBUTION
Blend B -- 0.48% Coke



T5PB48C

Task 5. Residual Catalyst Coke on Cracking Yields

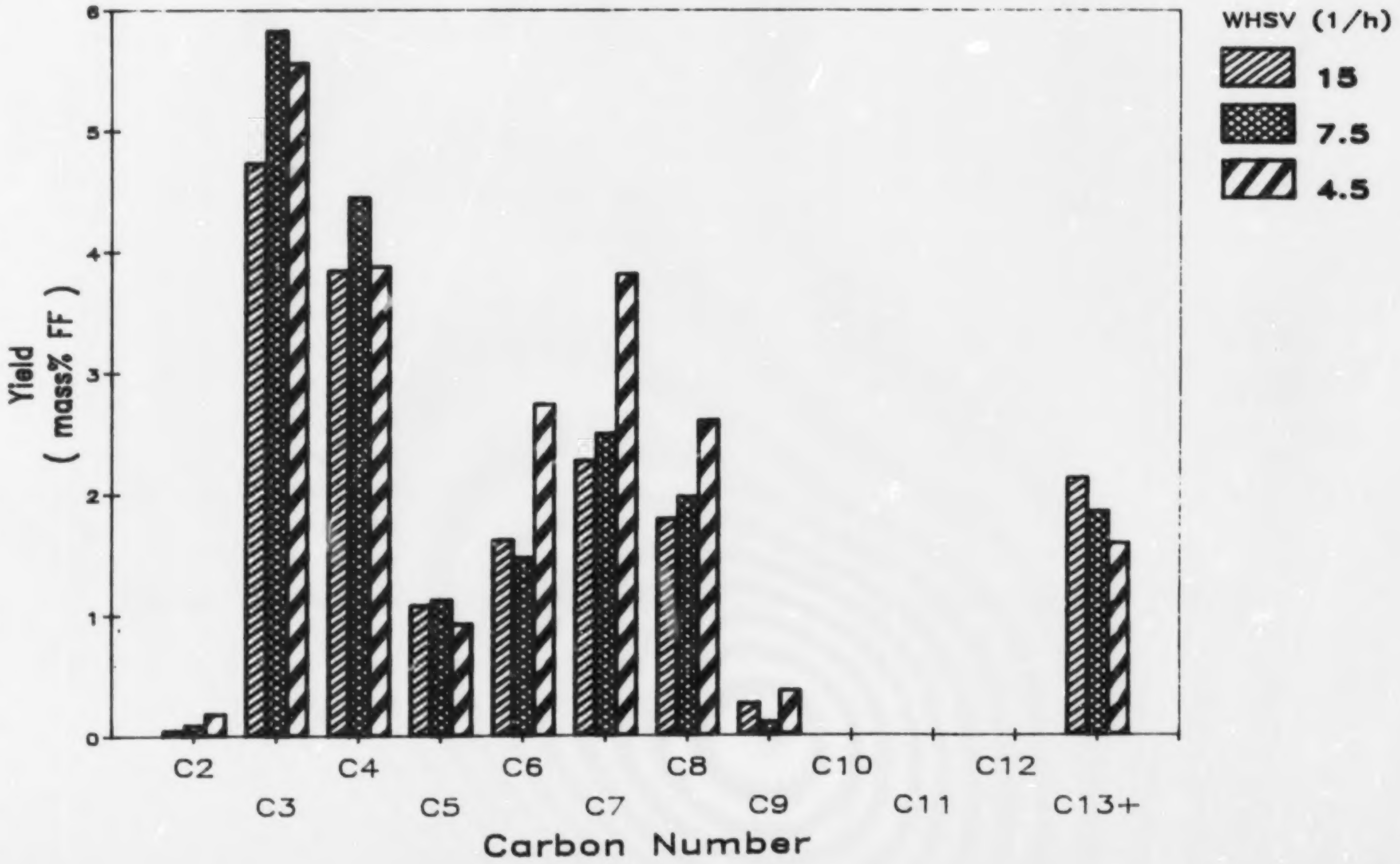
OLDFIN DISTRIBUTION
Blend B -- 0.11% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION

Blend B -- 0.27% Coke

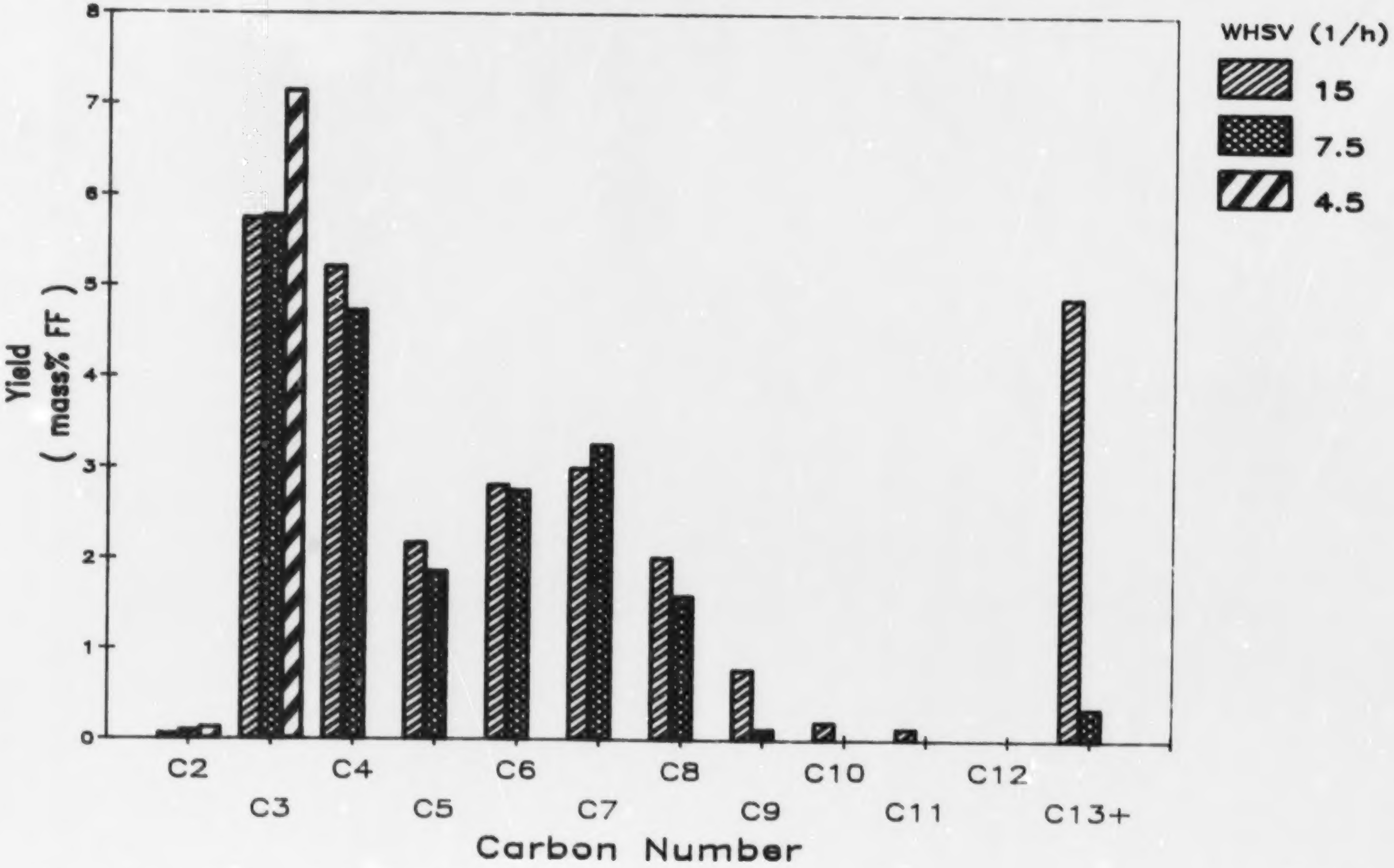


T5OB27C

Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION

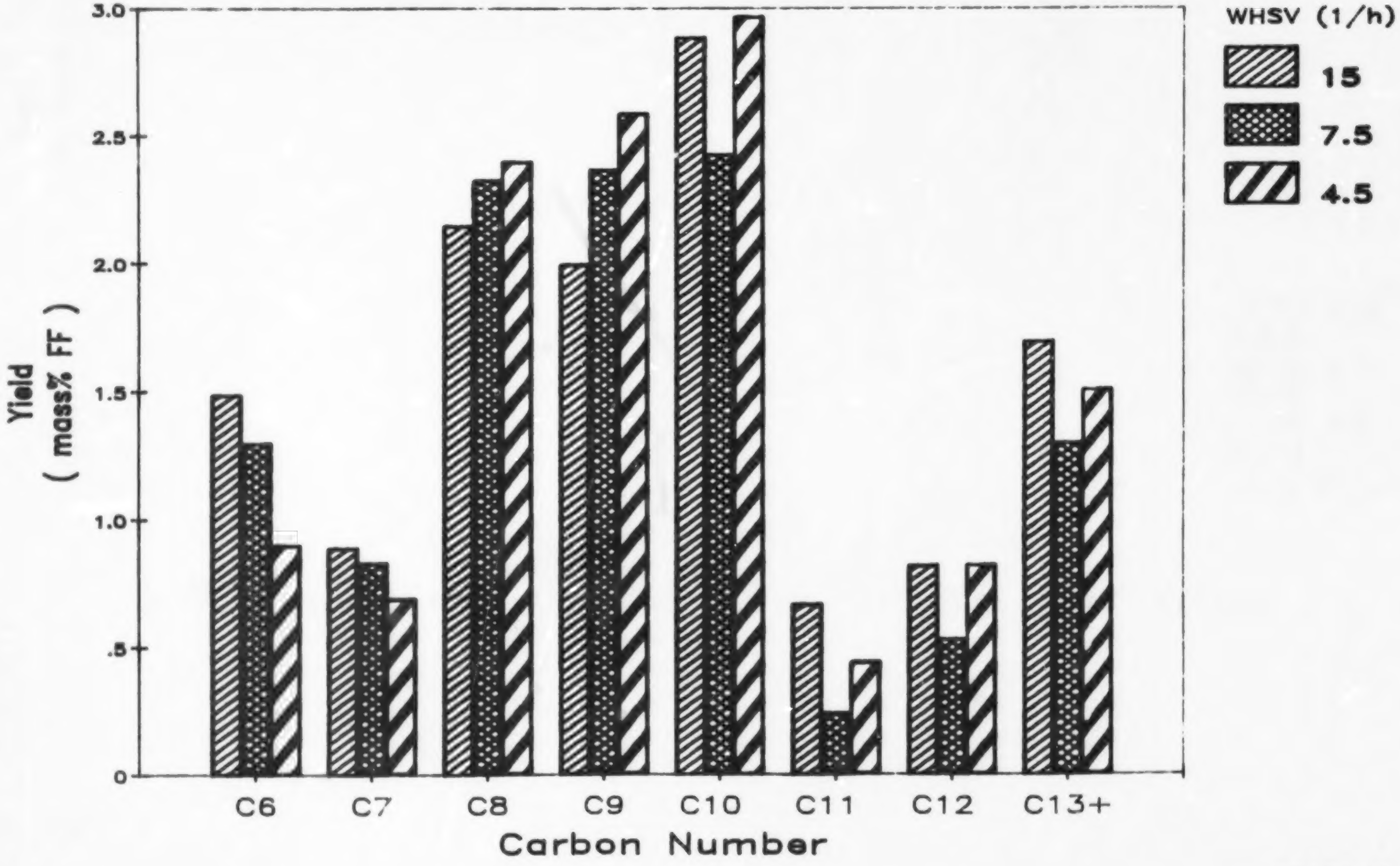
Blend B -- 0.48% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend B   Catalyst : 0.11% CRC

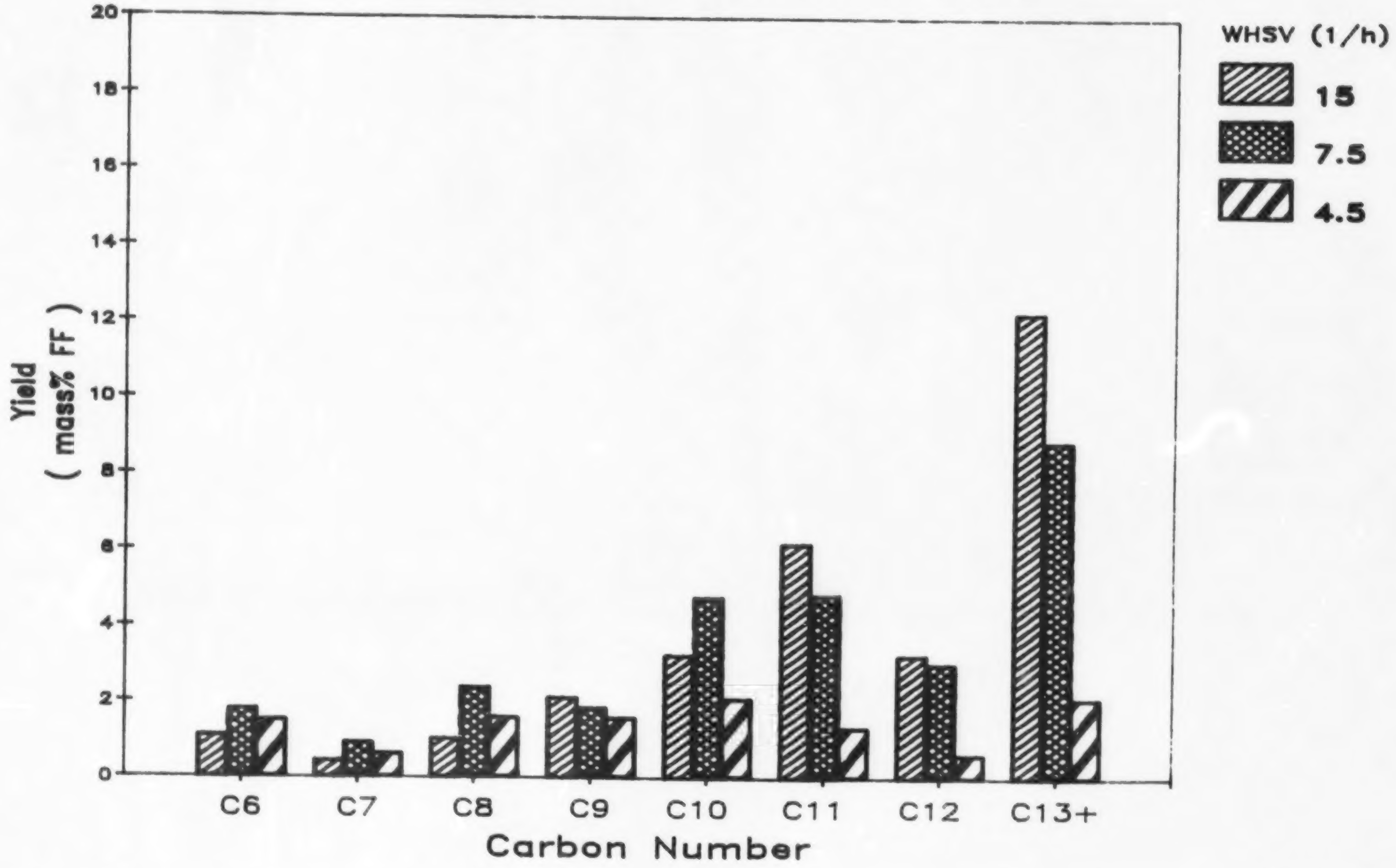


T5AB11C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

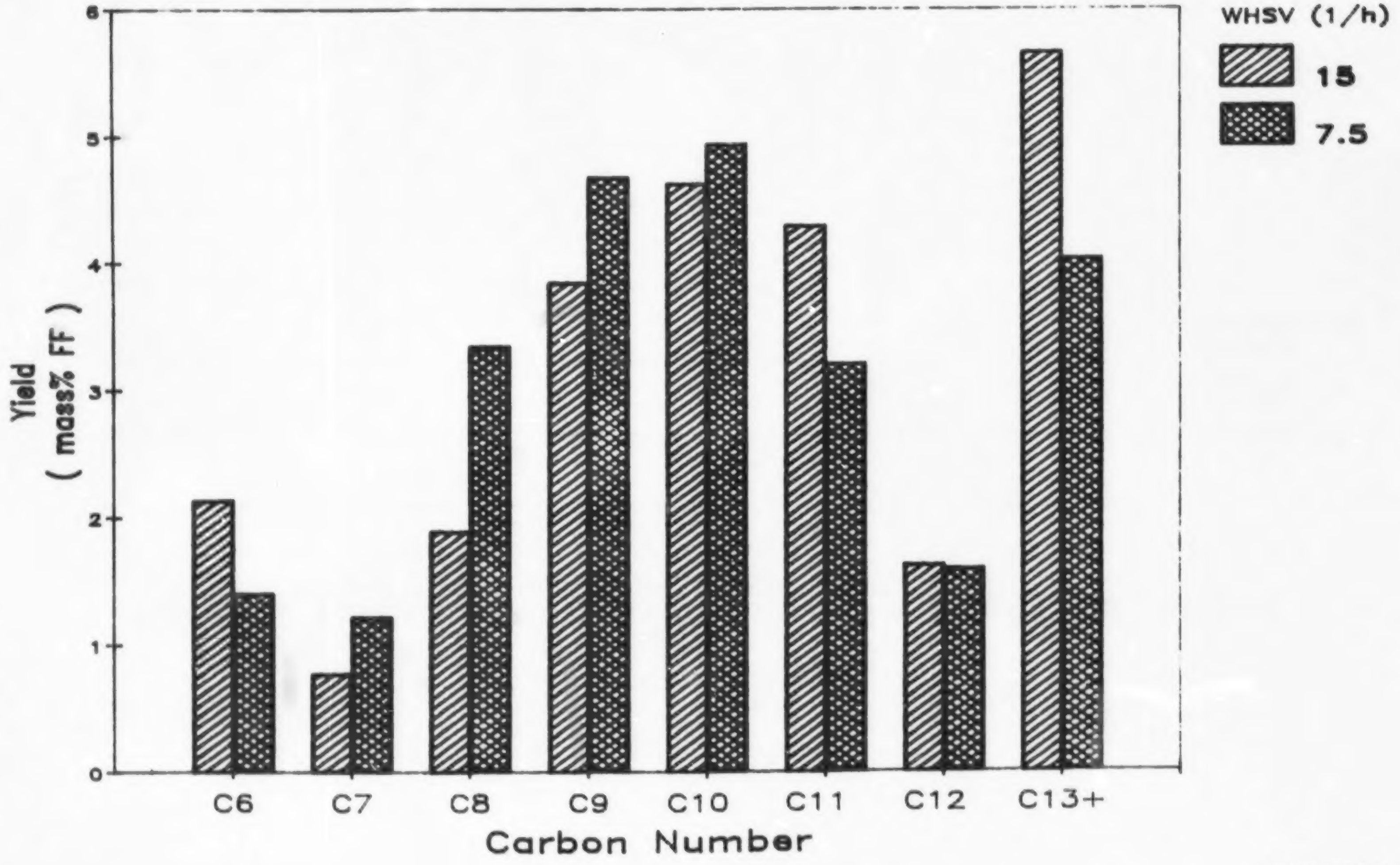
Feed : Blend B   Catalyst : 0.27% CRC



Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

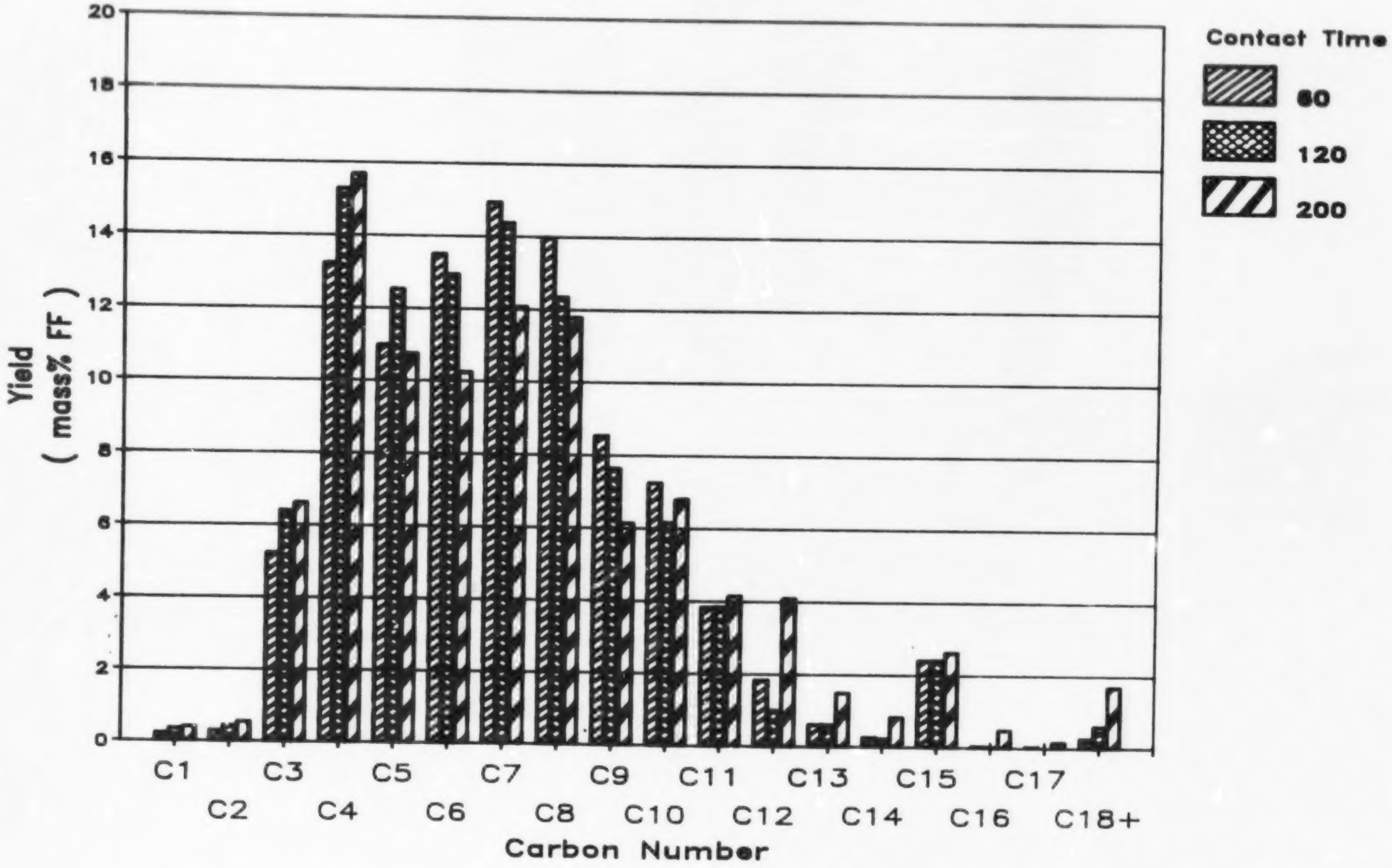
Feed : Blend B   Catalyst : 0.48% CRC



T5AB+8C

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend C   Catalyst : 0.11% CRC

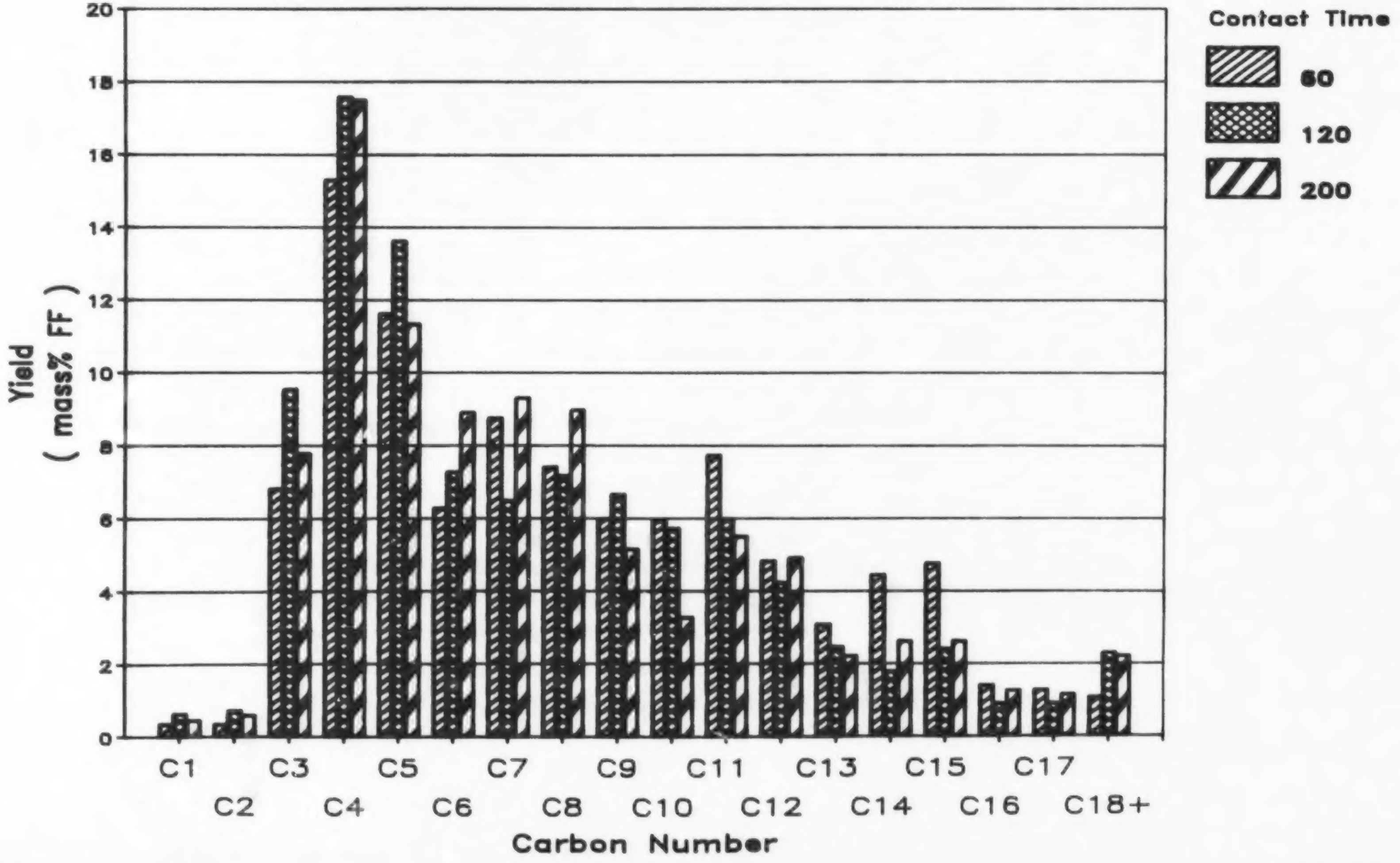


T5C11CD

Task 5. Residual Catalyst Coke on Cracking Yields

REACTOR EFFLUENT CARBON DISTRIBUTION

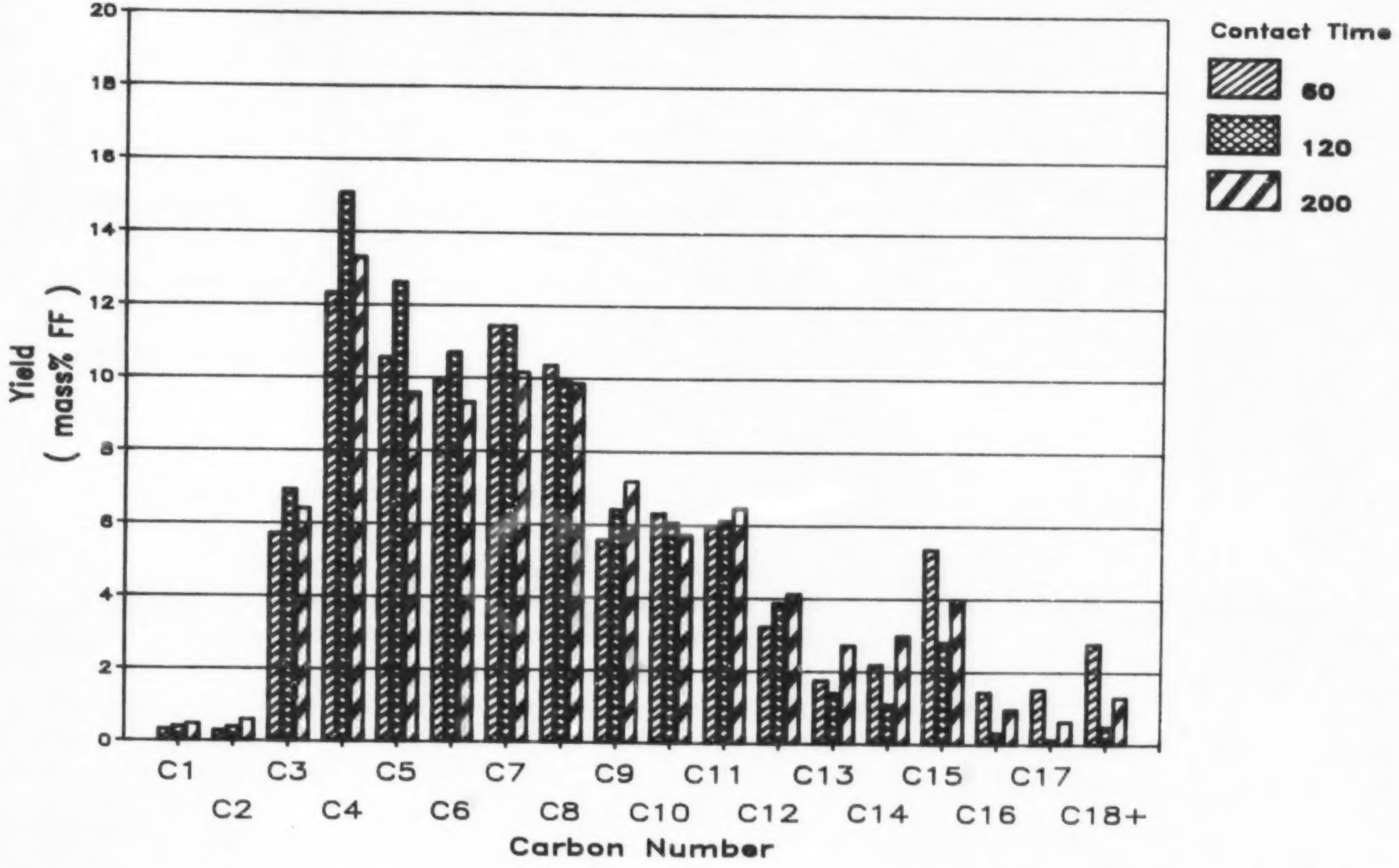
Feed : Blend C   Catalyst : 0.27% CRC



T5C27CD

Task 5. Residual Catalyst Coke on Cracking Yields

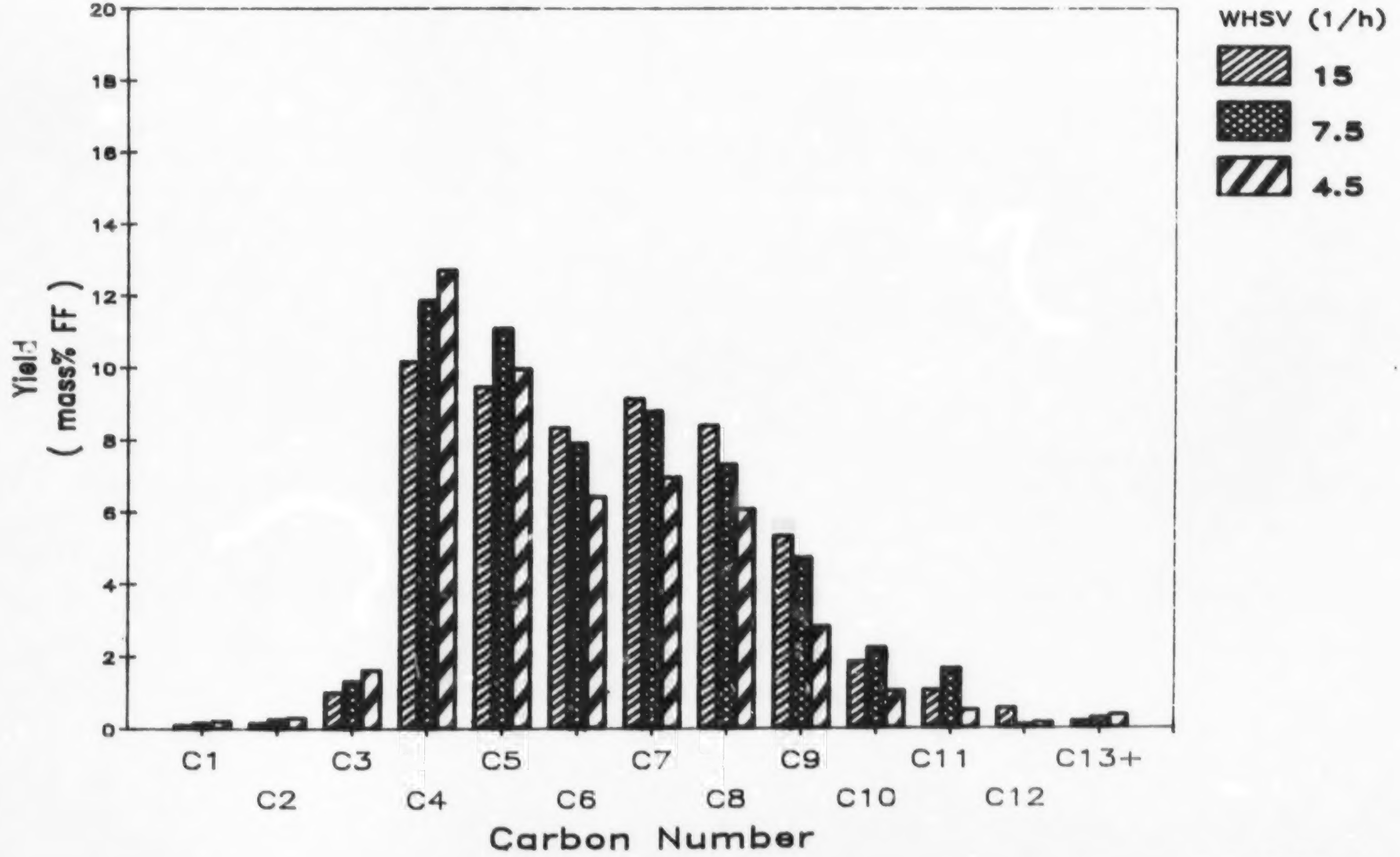
REACTOR EFFLUENT CARBON DISTRIBUTION
Feed : Blend C   Catalyst : 0.48% CRC



T5C48CD

Task 5. Residual Catalyst Coke on Cracking Yields

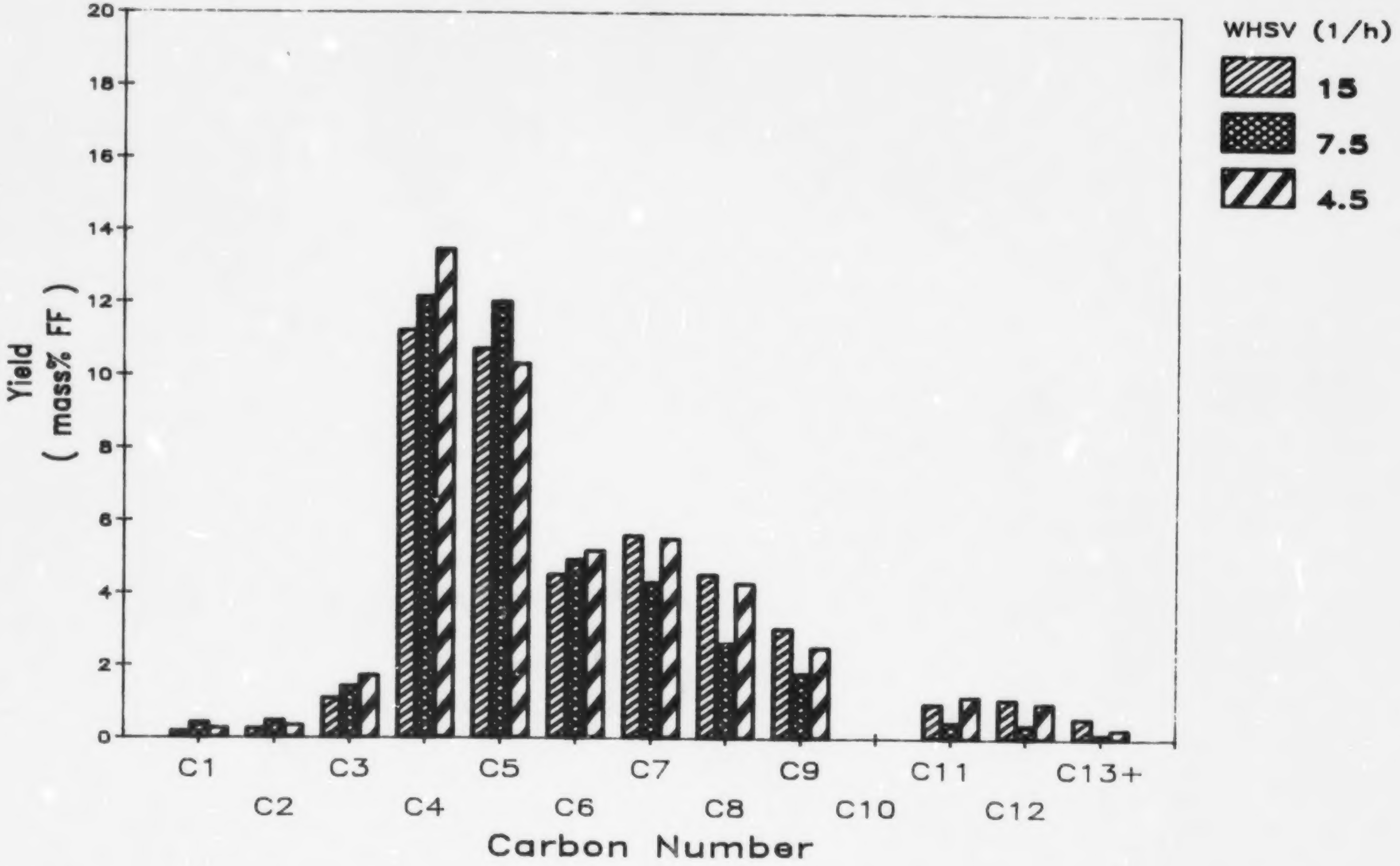
PARAFFIN DISTRIBUTION
Blend C -- 0.11% Coke



T5PC11C

Task 5. Residual Catalyst Coke on Cracking Yields

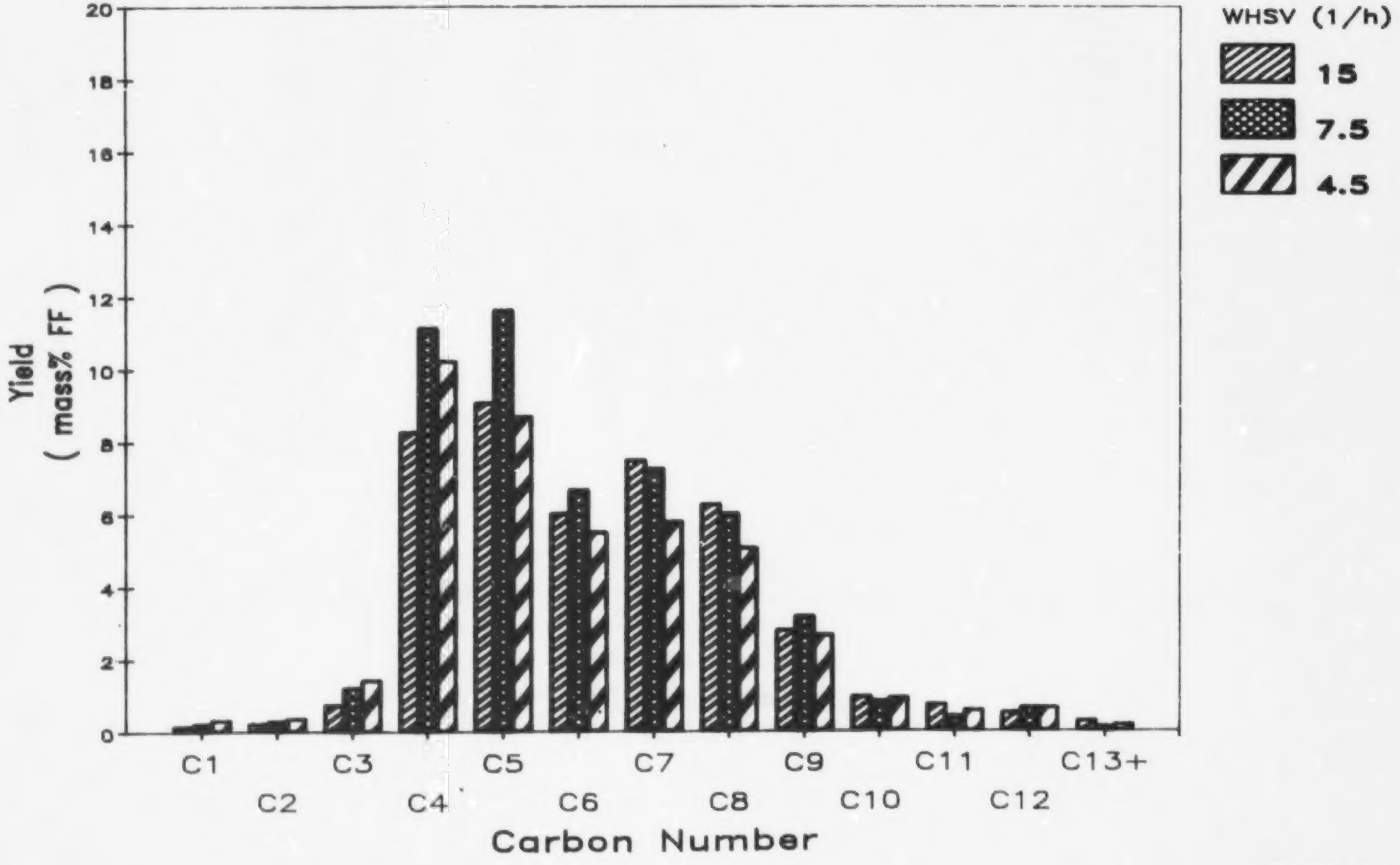
PARAFFIN DISTRIBUTION
Blend C -- 0.27% Coke



T5PC27C

Task 5. Residual Catalyst Coke on Cracking Yields

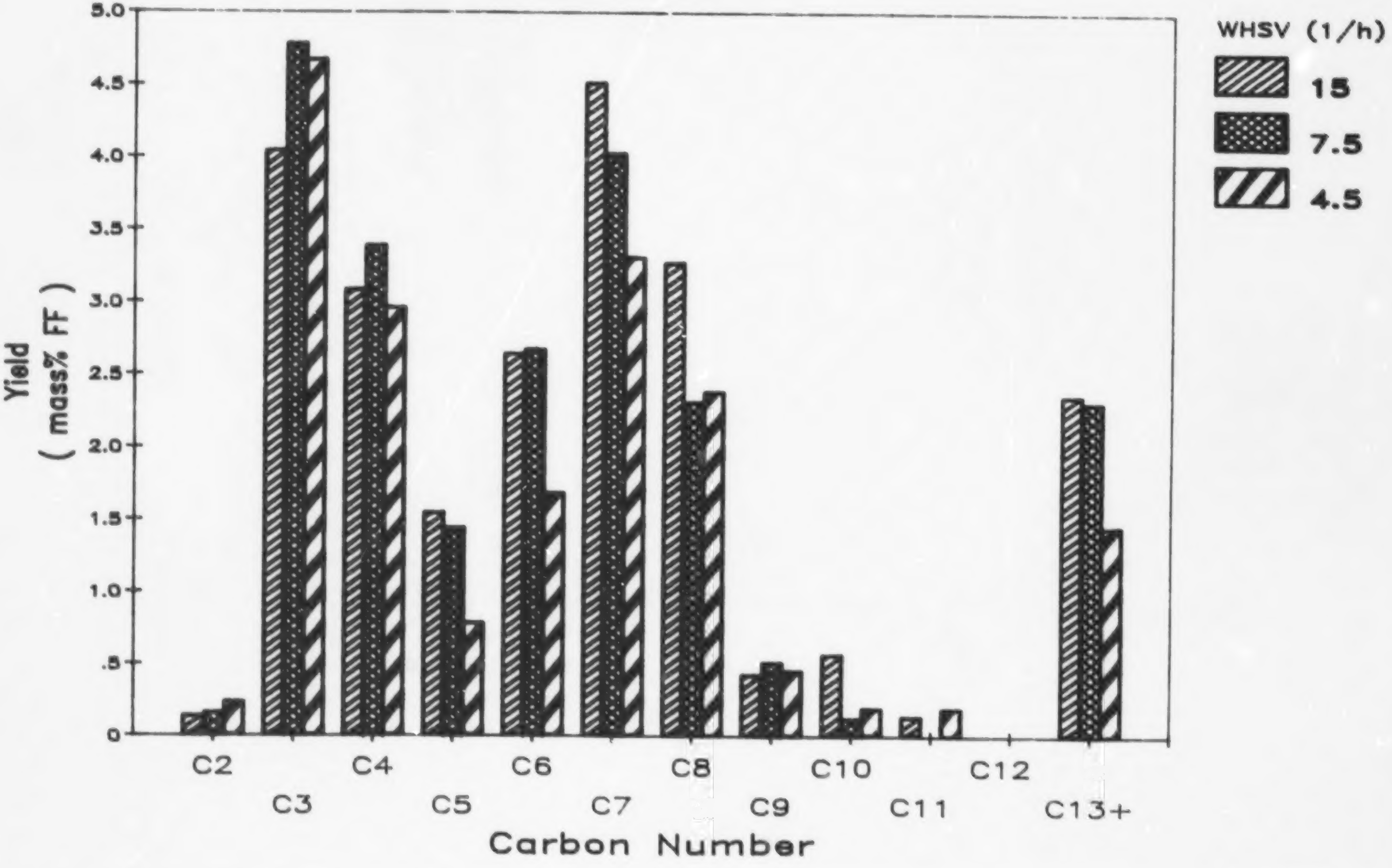
PARAFFIN DISTRIBUTION
Blend C -- 0.48% Coke



T5PC48C

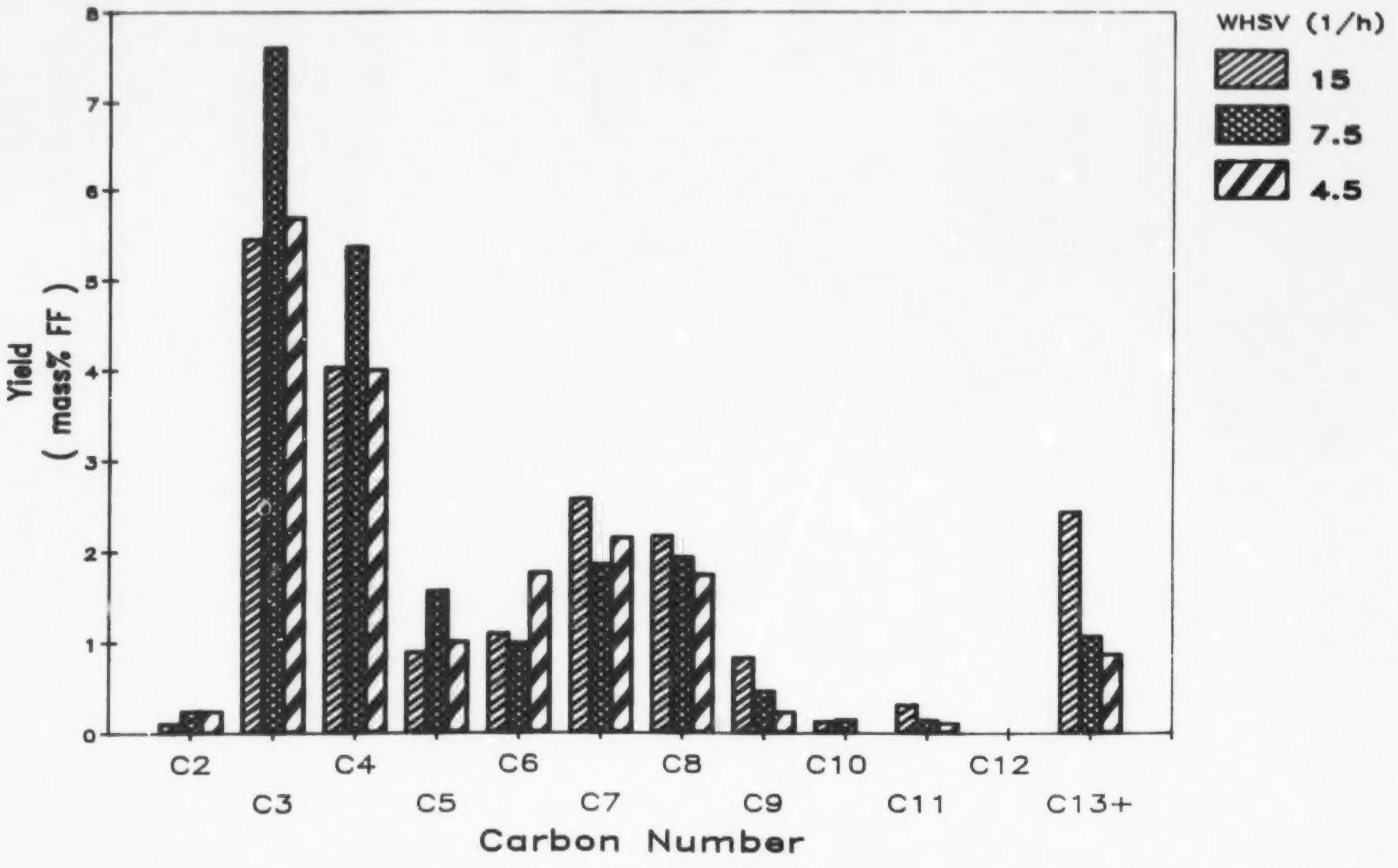
Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend C -- 0.11% Coke



Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION
Blend C -- 0.27% Coke

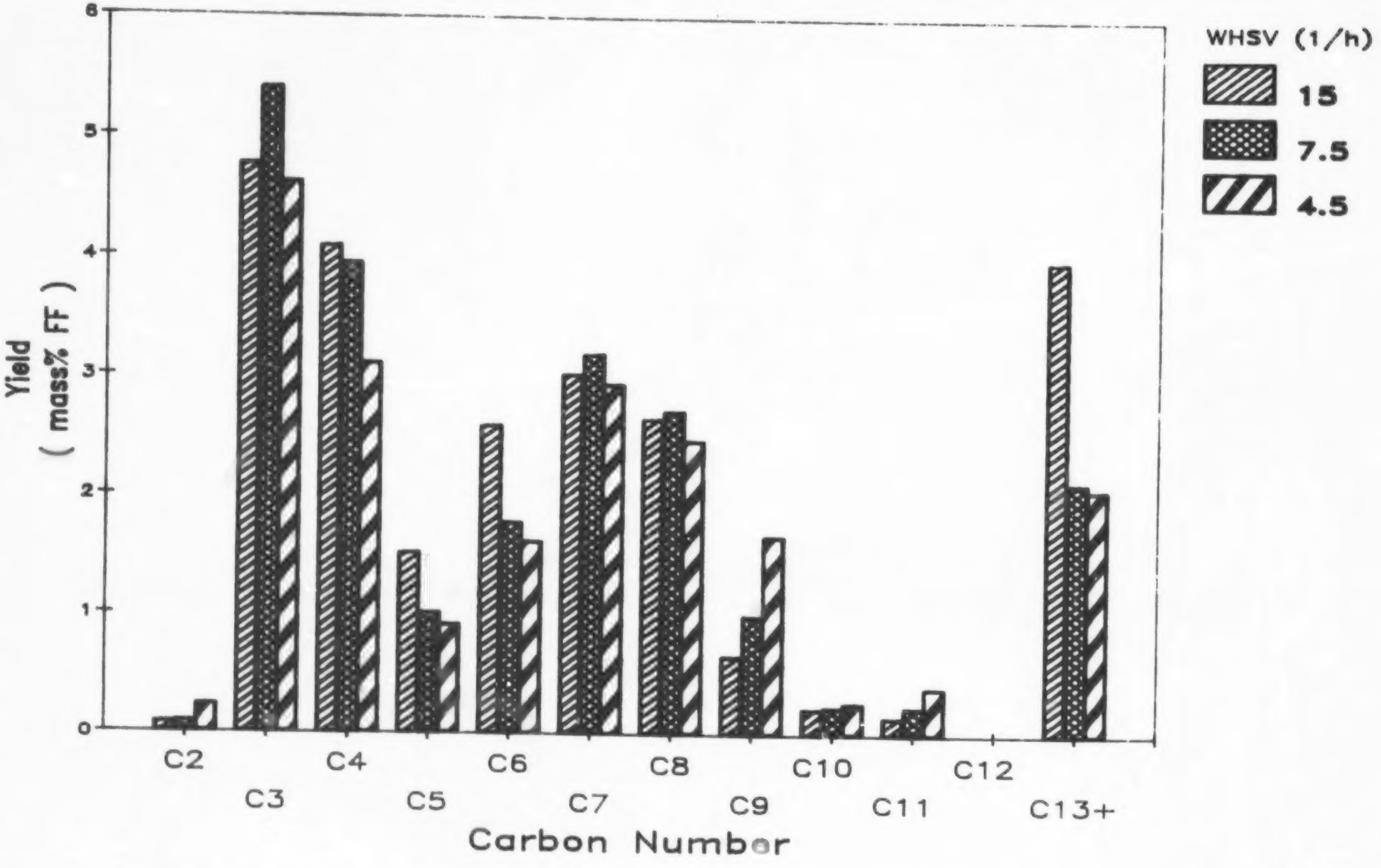


T50C27C

Task 5. Residual Catalyst Coke on Cracking Yields

OLEFIN DISTRIBUTION

Blend C -- 0.48% Coke

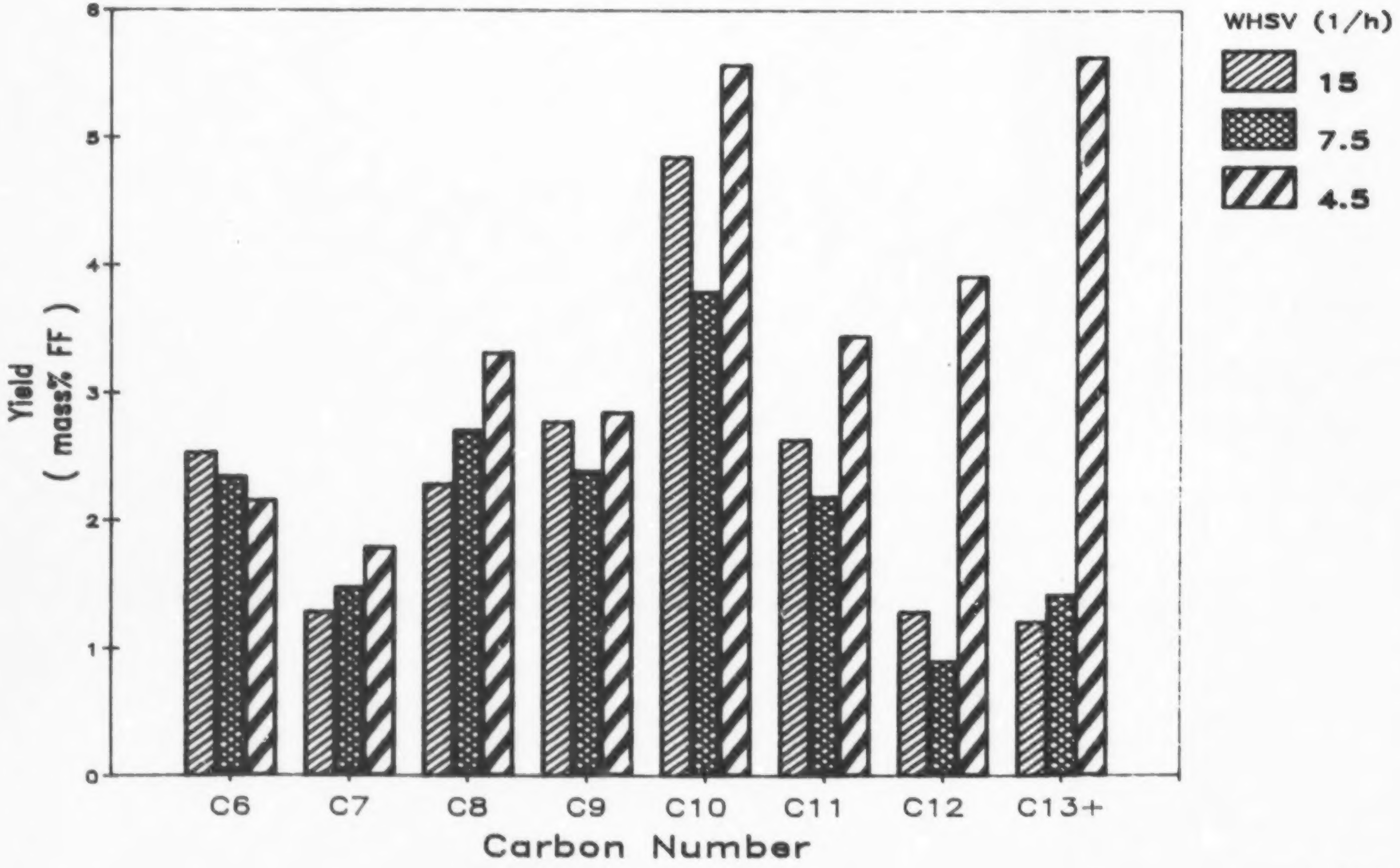


T5OC48C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend C   Catalyst : 0.11% CRC



T5AC11C

Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

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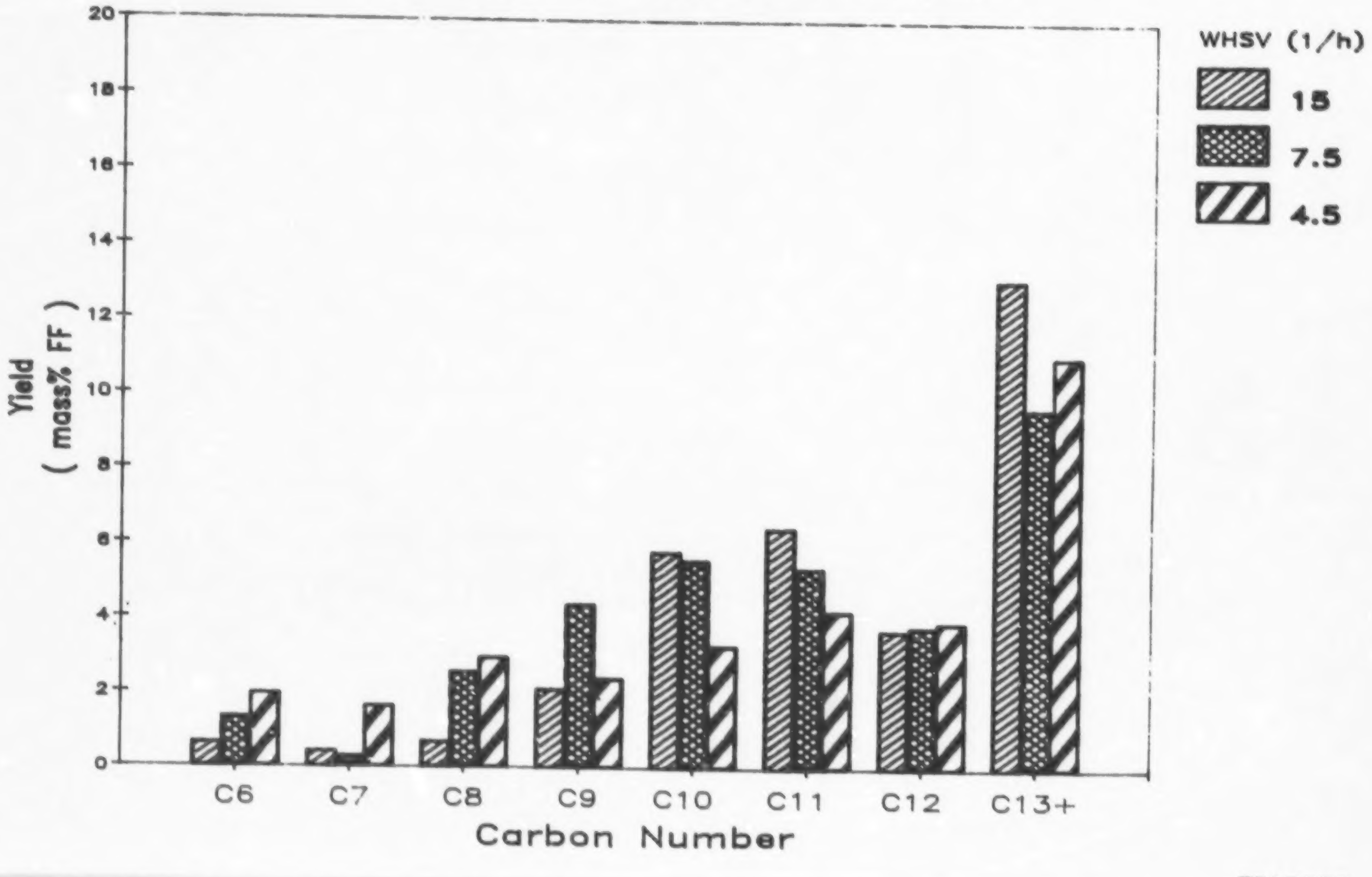
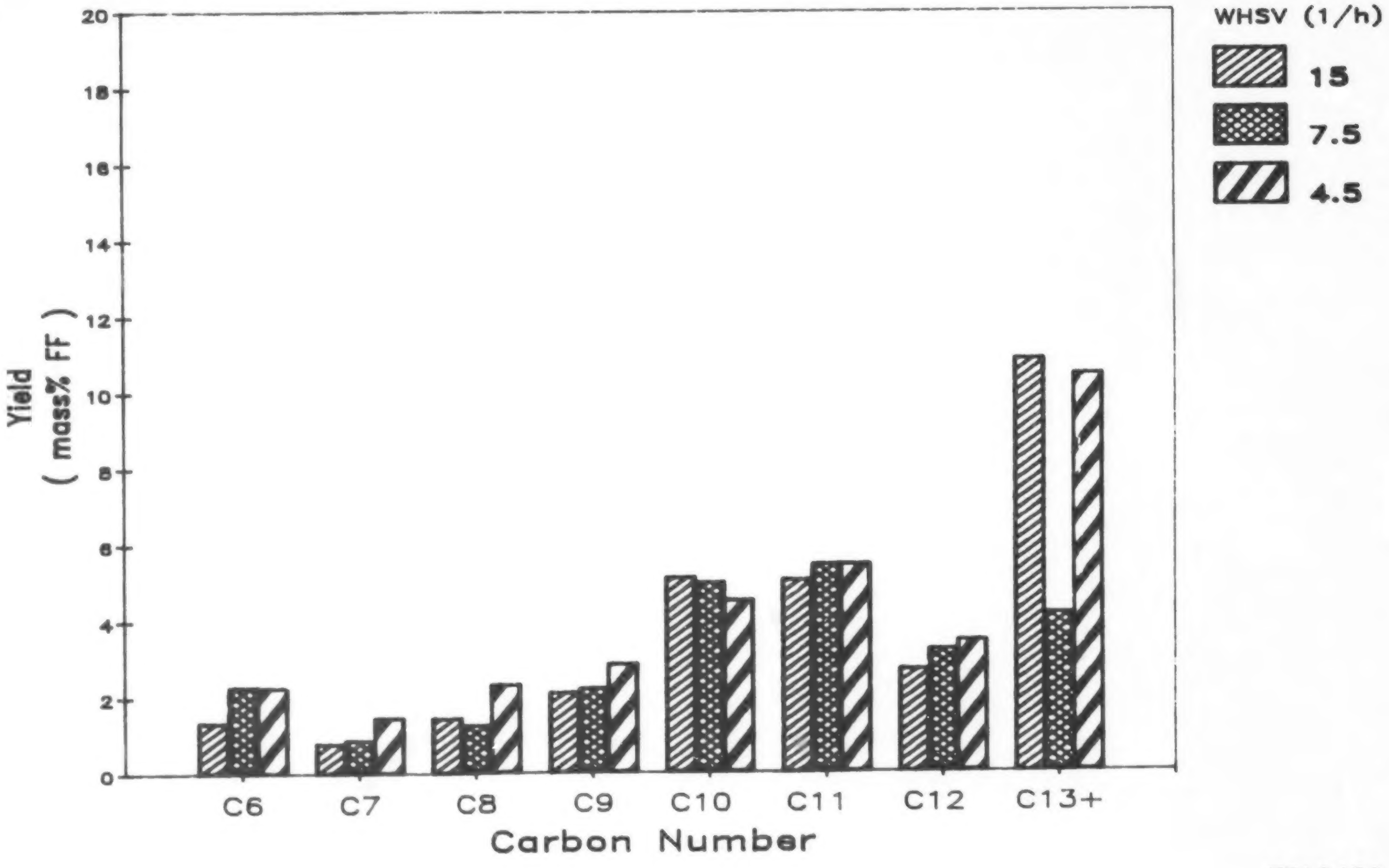


Task 5. Residual Catalyst Coke on Cracking Yields

AROMATIC DISTRIBUTION

Feed : Blend C   Catalyst : 0.48% CRC



T5AC48C